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THE PENNSYLVANIA R. R. PASSENGER STATION IN NEW YORK CITY.

The extension of the Pennsylvania R. R. lines by tunnel from New Jersey under the North River, Manhattan Island, and the East River to Long Island, and a connection with its Long Island system provides, as most of our readers know, for a passenger station of unusual size in New York City. The plans for this station have been practically completed by the Pennsylvania R. R. engineers and the architects, McKim, Mead & White, of New York City, and from them we have selected those shown in Figs. 1 to 4, to show the general type of structure adopted and the accommodations which it will furnish.

The new station is bounded on the east by Seventh and on the west by Eighth Aves.; on the south by 31st and the north by 32d St., 32d St. having been closed and included in the station site. The frontage on the avenues is 430 ft. and on the streets 780 ft., the sides of the structure forming a perfect parallelogram. As the tracks are 40 ft. below the surface of the streets the station is divided into three levels. From the street level upward the walls of the structure rise to the height of 60 ft., except in the center, where the roof of the general waiting room reaches a height of 150 ft., and at the corner of Eighth Ave. and 33d St., where there is an elevation of four stories for office purposes. The architectural design of the entire exterior is a Doric colonnade, 35 ft. high, surmounted by a low attic, raising the general elevation to 60 ft. The exterior construction is to be of pink Milford Granite.

The main entrance is fixed in the center of the structure on Seventh Ave., opposite the intercepted end of 32d St. This is for foot passengers only, and from the street entrance to the stairway to the main waiting room there extends an arcade 225 ft. long and 45 ft. wide, flanked by shops, which will be occupied by merchants, whose wares will appeal especially to the requirements of travelers. On either side of the Seventh Ave. entrance there are also a series of stores. At the further end of the arcade the restaurant, lunch rooms and the cafe are established, with proper kitchens and service connections. Beyond is the general waiting room and the concourse, all easy of access by convenient stairways.

At the corners of 31st and 33d Sts. and Seventh Ave. are open pavilions, which furnish carriage entrances for incoming and outgoing traffic. Under cover carriages descend from the street level by a slight gradient about 20 ft. to the level of the station proper, the 31st St. incline being assigned as an entrance and the 33d St. ascent as an exit. By this arrangement carriage passengers are delivered at the most convenient entrance to the general waiting room. Apart from the main entrance there are other convenient entrances for foot passengers from the street level to the general waiting room and concourse from both the streets and the avenues. At a central point in both streets wide bridges leading into the street floor of the station span the carriage subway.

On the intermediate plane or level the real business of the passenger preparatory to his journey is transacted. The general waiting room, the largest of its kind in the world, 320 ft. long, 110 ft. wide and 150 ft. high, is the central section of the plan. Within it will be located the ticket offices, parcel rooms, telegraph and telephone offices and baggage checking windows, all so situated that a passenger may proceed from one to the other seriatim, with a minimum amount of exertion and without retracing his steps. Adjoining the general waiting room on the west are two subsidiary waiting rooms, 58 x 100 ft., respectively for men and women, provided with seats, and opening into retiring rooms, with lavatories attached.

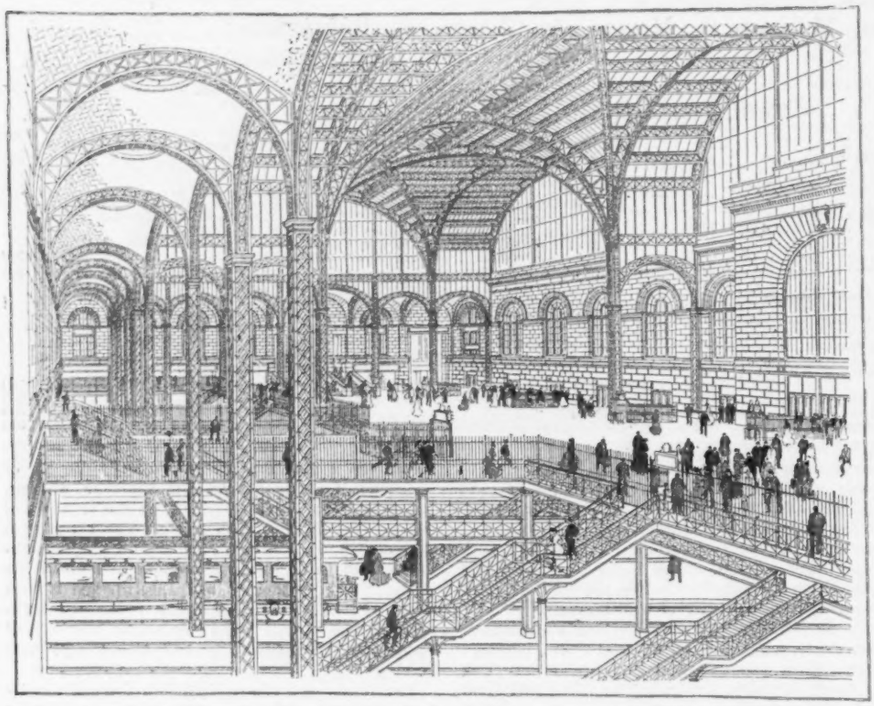
To the east of the general waiting room is located the main baggage room, with 450 ft. of frontage, for the use of the transfer wagons, covering the full area occupied by the arcade and restaurants on the plane above. The baggage is delivered and taken away through a special subway, 30 ft. wide, extending under and along the entire length of 31st St. and Seventh and Eighth Aves. From the baggage room trunks are delivered to the tracks below by motor trucks and elevators. The cabstands will also occupy this level.

Parallel to and connecting with the main waiting room by a wide thoroughfare and west of the subsidiary waiting rooms is the concourse, a covered assembling place over 100 ft. wide, extending the entire width of the station and under the adjoining streets. This may be termed the vestibule to the tracks, as two sets of stairs descend from it to each of the train platforms on the track level. The concourse and adjacent areas are open to the tracks, forming a courtyard 340 ft. wide by 210 ft. broad, roofed by a lofty train shed of iron and glass, similar in design to the famous train sheds of the new stations in Frankfort and Dresden, Germany. In addition to the entrances to the concourse from the waiting room there are also direct approaches from 31st, 33d Sts. and Eighth ave.

Auxiliary to the main concourse and located between it and the tracks is a sub-concourse, 60 ft. wide, which will be used for exit purposes only. This passageway is 18 ft. above the tracks, but is connected with the track level by two stairways and one elevator from each platform. From it ample staircases and inclines lead directly to 31st, 33d and 34th Sts., to Eighth Ave. and to future rapid transit stations under Seventh or Eighth Aves. Direct connection may also be made with the proposed subway stations on Herald Square without ascending to the street level.

The northern side of the station extending along 33d St. will be assigned to the suburban

PERSPECTIVE VIEW OF PENNSYLVANIA R. R. PASSENGER STATION, NEW YORK CITY.



INTERIOR VIEW SHOWING CONCOURSE AND TRACKS, PENNSYLVANIA R. R. STATION, NEW YORK CITY.

service of the Long Island R. R., into which trains will run from all points on Long Island by way of the East River tunnels. Ample entrances and exits are provided on Seventh and Eighth Aves. and 33d St., so that this traffic can be handled in connection with the adjacent subways and the surface lines on the surrounding streets independently of the rest of the station.

The third level, which is at a depth below the surface of the street corresponding to the height of a four-story building, is the track level. When the two tracks emerge from the tubes under the Hudson and reach the entrance to the station yards at Tenth Ave. they begin to multiply, and at Ninth Ave., and extending into the station, the total number has grown to 21. There is also a reduction in the number of tracks leading out of the station to the east, to a total of four for the main line, two passing under 32d and two under 33d St., and thence under the East River to the Long Island City yards. The track surface of the station may be compared to two unfolded fans joined together at the open ends, the handle of one extending under the Hudson and that of the other under East River. Within the station area, covering 25 acres of ground space, there are 16 miles of tracks. Through trains from the western side of the Hudson, after discharging passengers, will proceed at once to Long Island City, where the train yards and terminals will be located, thus leaving the station tracks clear of any idle equipment, and likewise the westbound through trains made up at the Long Island City terminal will pass through the station, stopping only to take up their quota of passengers. The suburban service of the Long Island R. R. will be operated on the "shuttle" plan, by which the trains are kept in continuous motion in and out of the station.

The planning of the station, with its numerous entrances and exits independent of each other and separating the incoming from the outgoing throng, was worked out to facilitate, in greatest measure, the prompt and uninterrupted movement of the traffic. The exposure of the building on all four of its sides to main arteries of street traffic gives the plan a flexibility, which is rarely obtainable in a building of such enormous proportions situated in the heart of a great city, and also insures the making of easy connections by underground subways with the future extensions of the city's rapid transit system under Seventh and Eighth Aves. and the cross streets. The designs for the station were made by McKim, Mead & White, architects, of New York, and will be executed under their direction.

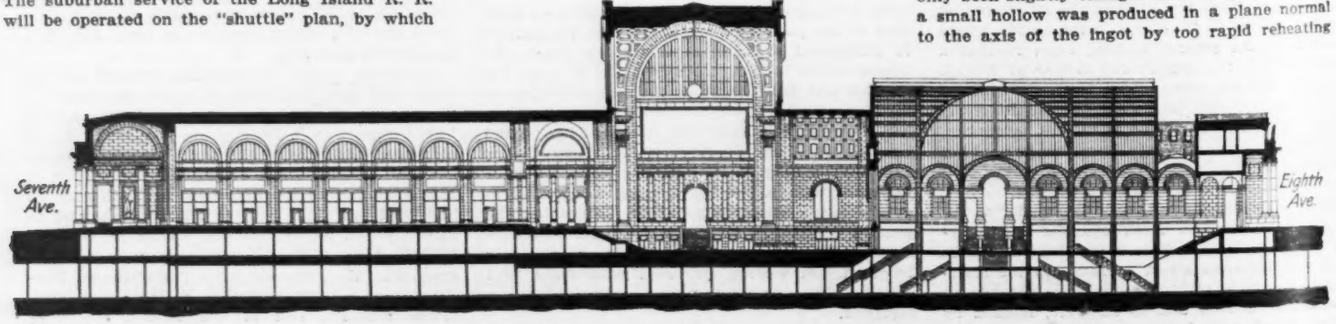
DEFECTS IN LOCOMOTIVE AND CAR WHEEL TIRES.

Three cases of tire fractures are described in a recent number of the "Revue Generale des Chemins de Fer" by Mr. Eugene Vanderheym, Engineer of the Paris, Lyons & Mediterranean Railway, France. One was on the coupled driving wheel of a locomotive, and the others were on passenger cars: all were of so-called "special" steel. The locomotive tire had originally a thickness of 3.04 ins., but at the time of fracture (and after a mileage of 2,032 miles since its last turning) this had been reduced to 2 ins. It broke transversely at two cracks about 10.4 to 11 ins. apart, and after removal from the wheel a longitudinal crack was found on the inner face, extending between the two fractures; the surface of the tread was intact. It showed a granular and crystalline structure and had evidently extended gradually under the pressure upon the rail, but it was not easy to explain the transverse fractures at its extremities, especially as the longitudinal crack did not extend to the tread. It was considered that when the tire was fitted it had no other defect than the internal fissure, and that this was due to conditions prior to the final rolling. Defects of this kind have several times been discovered, sometimes becoming apparent when the inner side of the tire is bored out or faced. The reason is believed to be that the piercing of the ingot after flattening has not entirely removed all traces of the central pipe or cavity, and that the ingot had been prematurely stripped and placed in an inclined position on the floor. Under these conditions, the soft or liquid metal at the heart of the ingot continued to flow, following an axis oblique to that of the ingot. It is evident that the ingots should not be stripped until the metal at the center has solidified, or that they should at least be kept vertical after the mold is removed.

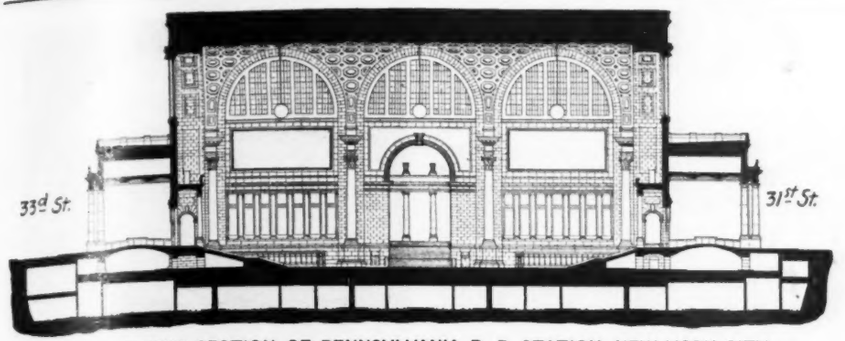
Of the two car wheel tires, one had been reduced from an original thickness of 3 ins. to 2.2 ins., and the other from 2.28 ins. to 1.8 ins. In each case a large internal cavity was found, and it was difficult to understand how such cavities could exist after the drawing out and the treatment received in the process of manufacture. An explanation was suggested by Mr. Harmet, of the St. Etienne Steel Works, and was accepted by the railway engineers. His idea was that the cavities are due to pipes produced by the internal stresses which are themselves due to too rapid and unequal reheating at the mill. The granular and crystalline appearance of the fractures supported this view, since the original hollow is produced at a temperature low enough for the metal to retain its crystalline structure, which appears on the edges of the separated surfaces. If the subsequent forging operations spread out these surfaces, they still retain this appearance, as the temperature at which these operations are performed are not high enough to sensibly affect the structure of the metal.

To test the reliability of this explanation, the engineers proposed to artificially form such a cavity in an ingot, and at the suggestion of Mr. Hugot, of the Firminy Steel Works, small blocks and plates of a refractory mortar were suspended in the molds by steel wires encased in refractory coverings. The ingots were then cast and made into tires in the usual way; the tires were cut open and showed cavities very similar to those in the tires which had broken in service. In one case, the rolling of the tire closed and extended the cavity so that it resembled a crack extending through almost the entire width of the tire.

As a further proof of the above explanation, it is stated that an octagonal ingot made at the St. Etienne works by the Harmet compression system (and consequently free from cavities) was drawn by forging into a square bar, and in the center of this bar there was found a cavity about 12 ins. long. The interior surface was covered with crystals absolutely white, whose form had only been slightly changed in forging. Evidently a small hollow was produced in a plane normal to the axis of the ingot by too rapid reheating



LONGITUDINAL VERTICAL SECTIONS OF PENNSYLVANIA R. R. PASSENGER STATION, NEW YORK CITY.



TRANSVERSE SECTION OF PENNSYLVANIA R. R. STATION, NEW YORK CITY.

of the ingot; then the action of the steam hammer transformed it into a cavity and gradually elongated it to form the 12-in. pipe found in the forged bar.

A BILL PROVIDING FOR GOVERNMENT DEVELOPMENT AND OWNERSHIP OF WATER POWER IN ONTARIO.

By J. A. M.

Agreeable to the simultaneous cry of the people of Ontario for cheap hydro-electric power, so strongly evidenced in the last month or so, and the advantages to the people made so apparent by the two reports on the subject lately submitted, namely, The Municipal Power Report and the Hydro-electric Power Report, the Government of Ontario has brought in a bill representing one of the most extensive experiments in public ownership of utilities in the history of Canada—or the world. It means that the government is going to take charge of unpreempted water powers and develop them wherever there is a demand for power. It is a brilliant and courageous program, and not only the people of Ontario, but also the whole world will watch with interest the course of the government which thus comes out boldly on the lines of that much-abused principle, more honored in theory than in practice, that the resources of the state belong to the people who own the state.

In the new bill brought down by the Ontario Government in the Legislature this week, the government assumes towards the province of Ontario almost the identical attitude which the city council of Ottawa has some time ago taken in connection with the citizens, and which has proved so successful. The Ontario Government proposes to ensure the people of Ontario a good supply of electrical power at reasonable rates. Where there is no power, the government commission—practically the present Hydro-Electric Power Commission—has authority to raise money on the vote of the Legislature, develop the power, and dispose of it to the municipalities within reach of the developing station. The more customers there are for the power, the cheaper will be the rates, because the expenses will be divided up among the consumers.

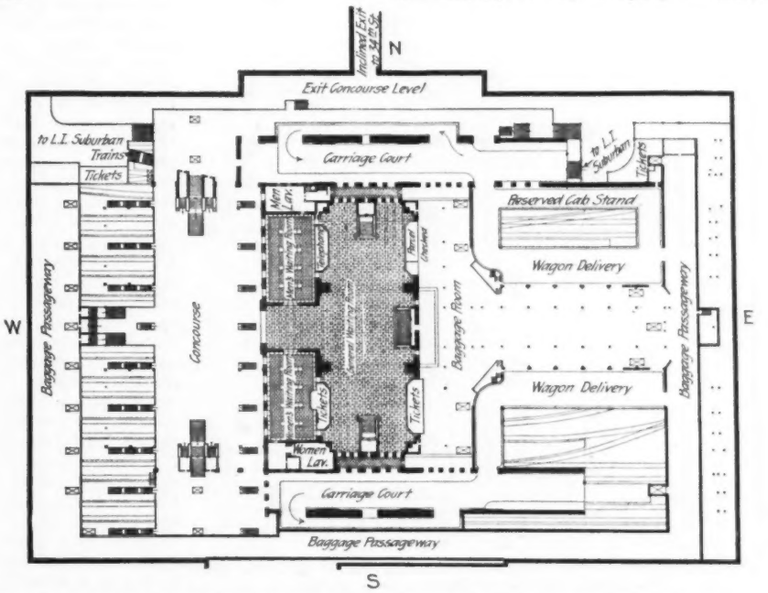
In localities where power has been developed by private capital, the government commission will take steps to ensure the people reasonable rates from such private corporations. If the corporations prove intractable, the commission can then consider whether it is better to expropriate the plants of the corporations or to go into the production of power on its own account in competition with private ownership.

When a municipality wants power, its people will decide by vote how much it wants and will then apply to the government commission to be furnished with the power at whatever is the prevailing rate, and, in addition to the price, will have to pay 4% on capital account, a sinking fund and proportion of operation expenses of the government plant in that particular section, and they will divide these with such other municipalities as are drawing a supply of electricity from the same plant. The bill provides that the commission shall be known as "the Hydro-electric Power Commission of Ontario," consisting of three members, who shall hold office during pleasure. Clauses enable the commission to furnish plans and specifications to municipal corporations, on application. The commission shall also act as an intermediary in furnishing electric energy to municipalities, but with the proviso that neither the commission nor the province shall be liable to any corporation or company on account of errors of omission in the plans, specifications or estimates prepared for its information.

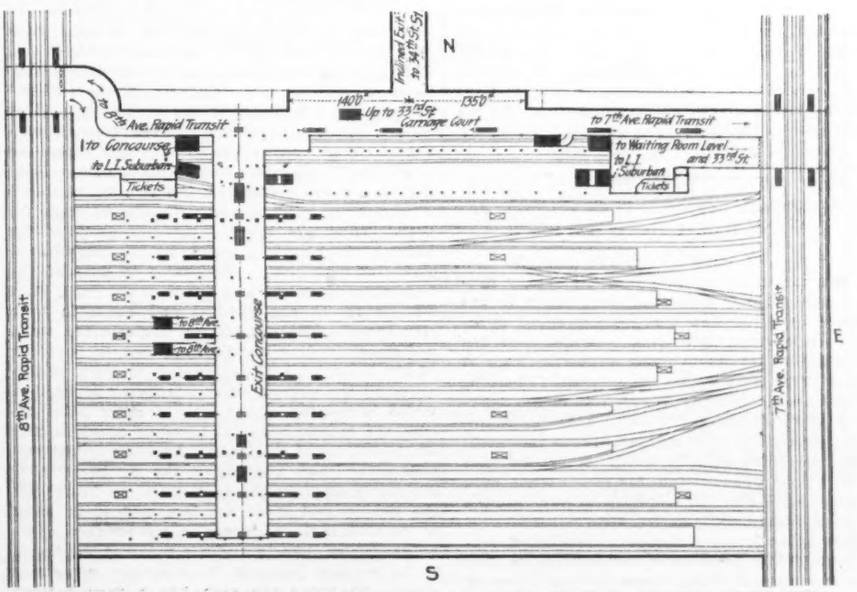
Under this system the capital required for the purchase of electric energy, to be supplied to municipal corporations for distribution, will be raised by Provincial loans, of which the proceeds are to be handed over to the commission for expenditure in carrying out its contract with municipalities. On the other hand, all sums received from municipal or other corporations in payment for electric energy must be handed over to the Provincial treasurer to be used in the retirement of the Provincial securities issued in connection with the loans.

The commission is further authorized to supply power to railways and distributing companies, and any net profit made by the commission in supplying such concerns, after making due provisions for the cost of works through which the power is supplied, "shall be applied in payment of the cost of maintaining the works, if any, acquired or constructed and operated by the commission for the purpose of transmitting power to municipal corporations."

Power is also conferred upon the commission to report to the government designating "such lands, water privileges, water powers of the lands, works, machinery and plant, or any portion thereof, of any company or individual,"



PLAN OF BAGGAGE AND WAITING ROOMS AND ACCESSORIES, PENNSYLVANIA R. R. PASSENGER STATION, NEW YORK CITY.



TRACK LEVEL PLAN OF PENNSYLVANIA R. R. PASSENGER STATION IN NEW YORK CITY.

operating or using any water privilege or water power in transmitting electrical or other power, or energy, which should in the opinion of the commission "be purchased, acquired, leased, taken or expropriated, developed, operated or used by the commission for the purpose of this act," or may designate what quantity of power produced or purchased by such company or individual the commission requires for the purposes of the act. The government may, at any time, give to the commission authority to expropriate the property of any company used for generating or transmitting electrical energy.

In a nut shell: (1) The Hydro-Electric Power Commission of Ontario is to fix rates of light, heat, power and gas companies in any part of the province. This provision applies to existing as well as future companies. (2) The government may authorize the commission to expropriate power plants and transmission lines, and to develop and transmit electrical energy to municipalities, distributing companies and railway companies. (3) Municipalities obtaining such energy from the commission are to pay back to the commission on a specified plan the cost of the works, the money for which is to be raised by the government and expended by the commission.

In the discussion following the introduction of the bill, the Premier stated that he had every reason to hope and believe that the drastic powers (in relation to expropriation or government development or transmission) would not have to be exercised by the government—that the existing power companies are prepared to accept the control of rates by the commission.

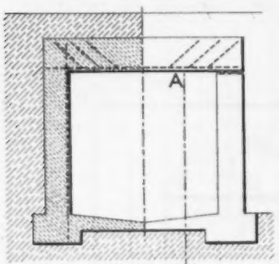


Fig. 1.

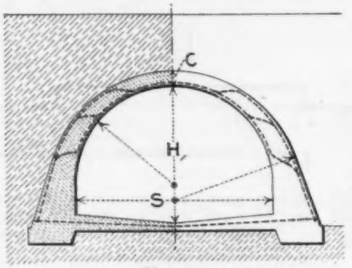


Fig. 4.

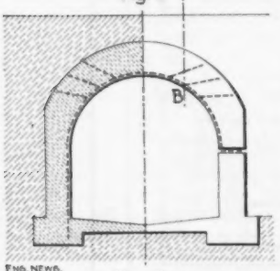


Fig. 2.

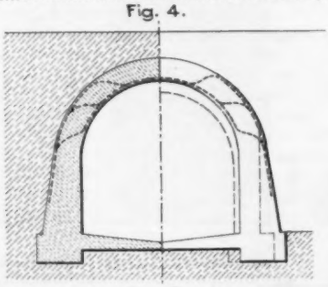


Fig. 3.

FIGS. 1-4. DIAGRAMS SHOWING RELATIVE ADVANTAGES OF BOX AND ARCH CULVERTS IN REINFORCED CONCRETE.

THE REINFORCED CONCRETE BEAM CULVERT: AN INEFFICIENT STRUCTURE.

By Daniel B. Luten.*

It is a rather remarkable fact that many railroads have of late shown an inclination to use concrete beam or slab culverts for small openings in preference to arches. One railroad has even gone so far as to make extensive tests of reinforced concrete beams for culverts. There is, of course, no longer any question as to the desirability of reinforced concrete as a bridge material; whether used as a beam or as an arch, it has advantages over every other material known at the present time for permanence with economy, solid roadbed, rapidity of construction and flood resistance.

Unlike other forms of masonry, reinforced concrete for bridges presents a new problem, in that it is feasible for small spans in the form of beams as well as arches. To the writer, the former use seems false economy, and with a view to arousing some discussion of the subject the following views are presented:

The argument most often advanced by the advocates of the beam culvert, as compared with the arch, is increased waterway. Two other arguments occur to the writer—a possible advantage in simplicity of arrangement of false work, and a greater ease of analysis. Taking up this last argument, while it is admitted that the reinforced beam is a comparatively simple structure and the arch a very complex one, it will be shown, nevertheless, that the supposed advantage is fallacious, since an arch designed by the very same method as the beam is the stronger structure of the two.

Thus, in Fig. 1 is shown a flat-top culvert of usual design, consisting of a concrete beam reinforced with steel tension members embedded near the lower edge and shearing members arranged diagonally near the ends, supported on reinforced abutments with bed of stream paved with concrete. It is an easy matter to determine the proportions of such a beam required to carry a given load, the beam being a comparatively simple structure from a mathematical standpoint; and formulas have been derived which can be relied upon with considerable accuracy. Fig. 2 represents an arch having the same span and height of opening and reinforced in a similar manner and with the same thickness of material at any point in the span. Mathematically, such an arch, covered with earth filling, becomes an exceedingly difficult problem for analysis; in fact, an impossible one, except for roughly approximate results. But a comparison of the two designs—the properly designed beam culvert of Fig. 1, and the arch culvert derived from it in Fig. 2—shows that the arch culvert is far the stronger and more efficient design, although by no means a properly designed arch.

Let us assume that both structures are as shown on the right of Figs. 1 and 2, limited by the vertical planes of backs of abutments and free from all horizontal pressures; in short, as if they were erected in the open and without any filling and still subjected to the intended vertical loads of earth and wheels. Or, better to illustrate, assume both beam and arch supported on rollers, so as to be absolutely free from all horizontal forces and unable to offer any resistance to horizontal thrusts. Now, with the same loading on the two structures, the bending moments at any given point of the span are the same for both. Thus, the bending moment at A of the beam is the sum of moments of all forces to the right of that point. The same is true of the bending moment at the point B of the arch, since all the forces are vertical and equal in both structures. (This, of course, neglects the small additional loading on the arch due to rounding of the haunches.) The bending moment is balanced by the moment of resistance of the section, which is greater in the arch at every point except the crown, where it becomes equal to that at the middle of the beam. At any vertical section other than the crown the compression is slightly greater in the arch than the beam, but the tension and shear are less, and at no point ot the arch is the compression greater than at its crown, which, like the middle point of the beam, is the weakest point in the structure, neglecting shear. In shear the arch has a very decided advantage over the beam, as the section is very much increased at the region of maximum shear.

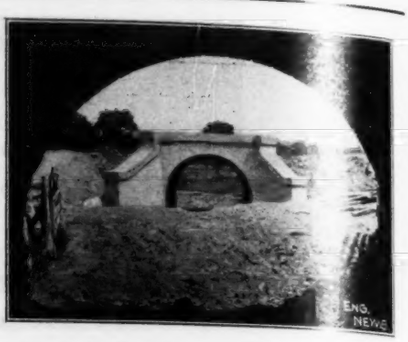


Fig. 6. A Reinforced Concrete Arch Culvert of 10-Ft. Span.

We have, then, the remarkable demonstration that a very badly designed arch, not even capable of resisting horizontal thrusts, which should be its basic principle, is as strong as a properly designed beam having the same section and reinforcement.

Let us now assume both structures under practical conditions, but still of the same section, as shown on the left of Figs. 1 and 2, with earth-fill back of abutments, rollers eliminated and stream faces of abutments reinforced against the earth pressure. Every ounce of pressure back of the abutments of the beam culvert tends to weaken the structure by increasing the compressive stresses in the upper fibers of the beam. The tensile stress in the steel reinforcement is reduced by the same amount, but this cannot be turned to advantage in the design, since at low temperatures the contractions of the beam will relieve this pressure and induce the full tension in the steel. Nor can any provision be successfully made in the beam for contraction or expansion, and the use of such beams in series of spans is of doubtful propriety.

In the arch of Fig. 2 every pound of pressure back of the abutments adds to the strength of the structure, since it sets up moments counter to those produced by the vertical loads, thus tending to reduce the bending moments at the weakest sections. In the arch, moreover, this strengthening pressure back of abutments is multiplied many times over the direct active pressure of the earth fill by the slightest distortion of the arch. An earth embankment may resist tons where but a few pounds of pressure will hold it to place, but the beam culvert provides no means of taking advantage of this fact. Every inch of upward curvature in a beam culvert increases its strength. Expansion and contraction in the arch are fully provided for by rising and falling of the crown without movement of abutments or piers. The arch of Fig. 2 therefore, although still of dubious design, is far more efficient than the well-designed beam of Fig. 1.

But the arched opening has 11% less area of waterway than the beam culvert; this calls for an increase of span and height of about 5½%, in order to equalize matters, as shown in Fig. 3, where the old section is seen on the right in dotted outline. In this Fig. 3, then, the arch has exactly the same area of waterway as the beam culvert of Fig. 1, but it has a lower center of

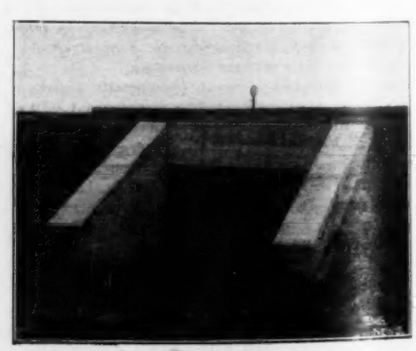


Fig. 5. A Reinforced Concrete Beam Culvert of 10-Ft. Span.

*President National Bridge Co., Indianapolis, Ind.

pressure than the latter, and consequently a greater discharge capacity for any flood height; and the material saved from within the opening by change of span and height has been transferred to the back of abutments, so that the arch has exactly the same amount of material in section as the arch of Fig. 2. But anyone at all familiar with arch design will readily concede that the material is more effectively placed in the revised design and that this arch is far stronger than that of Fig. 2, and consequently a stronger and much more efficient culvert than the beam culvert of Fig. 1 of the same waterway.

The reinforcement of Fig. 2 may with advantage be modified to series of rods near the intrados over the crown and near the extrados along the haunches, and with alternate rods crossing the arch ring at different points between, thus making a single series of rods reinforce the structure fully against both bending moments and shear, as shown in Fig. 3. This reinforcement may, moreover, be much lighter than the beam reinforcement, nothing more being required than to provide for live load tension and temperature changes, both of small moment in a well-designed arch when compared with a beam.

Notwithstanding the fact that the arch of same section and waterway has now been shown to be by far the stronger and more efficient structure, it will still be urged by some that the haunches of the arch tend to form lodging places for floating ice and debris. It is granted that in certain forms of arches, where a circular segment has been employed with low springings, debris would lodge and stick in the sharp angles at end of span, but that a semicircular or elliptical arch will behave thus, the writer would deny. The haunches of the arch tend to deflect the current downwards at those points, producing a suction that draws floating debris down and through the arch, and any debris that might be held against the haunches temporarily is drawn into the span as the water falls, so that the arch culvert is not at a disadvantage as compared with the flat top in the matter of flood debris. And for spans of upwards of 20 ft., where a single-span arch is almost always feasible, while a beam bridge must be built with piers, the arch has all the advantage.

By building a beam culvert with girders projecting below, a considerable economy of material may be effected, but only at a serious sacrifice in waterway; the arch is susceptible of the same treatment with less sacrifice of waterway. The arch has, in addition to all the aforementioned advantages, a rounded top, which, when covered with earth filling, gives a gradually decreasing cushion for impact of live loads, while the beam culvert receives its full load suddenly at the end of the span.

One slight advantage is conceded to the beam culvert, in that the forms may be erected without the cutting of curved members for the centers. The writer has in mind repeated instances where all the centers for an 8-ft. culvert, costing from $700 to $900, were cut in a single day from 1-in. boards by a carpenter using a draw shave and rule as his only tools. The cost, including the lumber for the curved parts treated as waste, was less than 1% of the cost of the structure—not a very serious drawback as compared with the gain in strength due to arching the beam, which, by careful design, may be made as great as 200 or 300%.

The revised design of Fig. 3 is still not an efficient arch culvert, but may be materially improved, as shown in Fig. 4, by increasing the span 25% and decreasing the height, so as to provide the same waterway. The center of pressure is thus very much lowered and the discharge very greatly increased, even when submerged by slack water. A steel reinforcement passed through the pavement from abutment to abutment becomes the tension chord of the structure placed at a maximum distance from the compression member instead of at a minimum distance, as in the beam. This lower reinforcing member also serves as an anchorage for the arch reinforcement, which, when arranged in single series and attached to the lower rods, are maintained in exact position during the concreting of the arch. This design, with the same waterway as the beam, a 25% greater span, and a consequent greater discharge capacity, requires 20% less concrete, 50% less steel reinforcement, and yet will carry twice as great a live load for any span above 4 ft.

What, then, is the reason that, with every advantage in favor of an arched structure, engineers who claim to be good designers of masonry structures will choose a beam culvert in preference to an arch? The writer is unable to give any satisfactory answer. Either the engineers have not given such matters sufficient study, or else they entrust the design to subordinates who cannot be permitted to handle so complicated a structure as an arch. That the former is possible is abundantly evidenced by the fact that of all the concrete arches that have recently been erected by our railroads not one in five shows a proper solution of that simple problem—the joining of a battered wing to the arch. The solution is given in most text-books on masonry, yet the culverts are built with battered bench walls or with wings vertical from springing down.

If the complexity of arch design is the difficulty, then attention is called again to the fact that every inch of upward curvature in a beam multiplies its strength when supported on abutments backed by earth filling.

The following method of designing semicircular arches of reinforced concrete for spans up to 50 ft. and with not more than 10 ft. of fill over crown is suggested as short and simple enough for those who are tempted to use the beam culvert. While the resulting designs are not the most economical and may be improved upon by careful analysis, yet they give results that will prove far more efficient than beam culverts for railway loadings.

$$\text{Crown thickness} = \frac{\text{span}}{30} + \tfrac{1}{3}.$$

Outer circle drawn with center $\frac{1}{10}$ of span below center of inner circle.

Back of abutments tangent to outer circle and battered one in four.

Square inches of steel required to reinforce one edge of arch for 1 ft. in width $= \dfrac{H\ L}{400{,}000\ C}$.

Where H is height of opening in feet, C is crown thickness in inches, and L is live load in pounds that can be concentrated on single-track over half-span.

If the arch is reinforced near both edges instead of as shown in Fig. 4, the steel near the other edge must be added to the area given by the formula. If reinforced by a single series of rods, they should cross the arch rib at points one-third, one-half and two-thirds of the distance from springing to crown.

A COMPOUND RAIL FOR STREET RAILWAY TRACK.

Compound rails for street railways (as well as for steam railways) have been the subject of frequent inventions and designs, but have rarely met with any success, one of the principal causes of failure being the apparent impossibility of keeping the fastenings tight and secure, so as to maintain the several parts as one solid piece. A new system now being tried in England seems to promise better results, as far as the mechanical design is concerned, but whether it can be established commercially must remain to be seen.

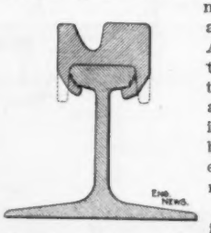


Fig. 1. Section of the Romopac Compound Rail for Street Railway Track.

In this system, which is shown in Fig. 1, the permanent portion of the rail resembles a deck beam, the small head having a flat surface and sides inclined inwardly towards the web. The cap, or wearing head, is a rolled-steel bar of channel section, with a grooved surface in accordance with general English practice. When these caps are laid in place upon the girder portion of the rail, a machine is run over them carrying small serrated rolls driven by powerful gearing,

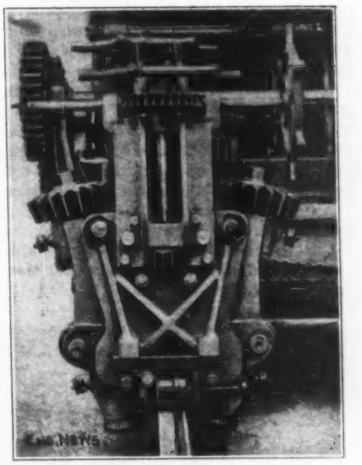


Fig. 2. Machine for Securing the Cap of the Compound Rail.

and these rolls bend the flanges or side webs of the channel rail inward until they are in close contact with the sides of the head of the girder. This part of the machine is shown in Fig. 2. When the cap is worn and requires renewal, the same machine is run over the track, cutting a deep groove in one of the flanges and splitting off the flange so that the cap can be removed. The cap represents about 40% of the total weight of the completed rail, and is laid to break joint with the permanent or girder portion. In building new track, the concrete substructure is laid and the girder portions of the rails set in place, connected by the usual arrangement of transverse tie-bars or rods. The caps are then set in place and secured by the process above described, the machinery being mounted on a self-propelling car fitted with a steam engine and traveling at a speed of about 10 ft. per minute. For renewals, it is only necessary to remove the paving alongside the rail, to give room for the cutting rolls and breaking-off device. The manager of the Leeds street railways estimates that the cost of renewal in this way would be only about half that of the ordinary system, which requires the paving to be torn up and the entire track removed and replaced.

This system is being introduced by the Romopac Tramway Construction Co., of Leeds, England, which has already laid a short experimental piece of track for the municipally owned street railways in that city.

MECHANICAL FIRING ON LOCOMOTIVES.

Mechanical stokers for locomotives were discussed recently in a paper by J. W. Cool before the Central Railway Club in a meeting at Buffalo, N. Y. Mr. Cool took an attitude distinctly favorable to the mechanical stoker. He gives principal credit to the uniformity of fire which it secures. This reduces the temperature variations in the firebox and flues, and in consequence lessens the trouble from leaking sheets and tubes. Less clinkering is observed, so that an engine can run longer without requiring the fire to be cleaned; the author states that he has known engines to run 900 miles without cleaning the fire, which could not have been done with hand firing. His opinion is stated briefly in the paper as follows:

I think the stoker has come to stay. The stoker as it is to-day may not come up to the requirements, but the details will be worked out. I think they have the right principle to work on. Snuperintendents of motive power have sought to train their men to fire a little coal at a time and fire frequently to avoid black smoke. The stoker gives a response to this idea, as it delivers from a fifth to a tenth of a shovelful at a time, which does away with the clouds of black smoke emitted from the stack by hand firing.

I think flues and fire-box will last longer with a stoker but I do not believe there is economy in fuel by the use of the stoker over a first-class fireman.

The discussion of the paper expressed opinions which agreed in substance with those of the author. The mechanical stoker is considered to promise success; it is not yet perfected in practical details, but will ultimately be a necessity on large locomotives hauling heavy trains.

STEEL FLAT CARS FOR SPECIALLY HEAVY LOADS.

Cars of special capacity and construction are required for the transportation by rail of exceptionally heavy and bulky articles, such as guns, bridge members, machinery, castings, wire cables, etc., and the great increase in number, size and weight of such articles within the past few years, has made the use of these special cars increasingly necessary. Steel flat cars of 50 and 60 tons capacity are used for this service by a number of railways and large manufacturing companies, and cars of higher capacity are in use to a limited extent, the maximum being the cars of 100 tons capacity which are described (with other cars) in this article.

Probably the heaviest single piece or load ever carried was the 122-ton Krupp gun exhibited at the Chicago Exhibition in 1893. For transporting this, a special duplex car was built, and was illustrated in our issue of April 20, 1893. The gun was supported by a frame consisting of a pair of plate girders 52 ft. 10 ins. long, each end of the frame being seated on the middle of a 20-ft. distributing girder, parallel with the frame. Each end of each of these girders rested in turn on the middle of a steel flat car having four wheels journaled in plate frames, with a wheelbase of 12 ft. 9 ins. The total wheelbase of the 16 axles was 80 ft. 3 ins. The complete combination car weighed 175,000 lbs., and the gun (with fastenings, etc.) 270,000 lbs., a total of 445,000 lbs. This gives 13,906 lbs. per wheel, or 5,545 lbs. per ft. of wheelbase. In our issue of Jan. 30, 1892, we illustrated the methods of transportation employed for an American 50-ton gun on a single steel flat car having four trucks, and a 66-ton French gun on two separate cars (one with four and the other with five axles). In the former case, the load on the two outer trucks was estimated at 80,000 lbs., and adding to this half the weight of the car (54,800 lbs.) gave a load of 107,400 lbs. on a wheelbase of 13 ft. 3 ins., equivalent to about 8,100 lbs. per lin. ft. of wheelbase.

100-TON CAR: ALLIS-CHALMERS CO.

The car shown in Figs. 1 to 4 is the first of two cars recently ordered by the Allis-Chalmers Co., of Milwaukee, Wis., for the transportation of large castings and parts of machinery. It was designed under the direction of Mr. A. E. Manchester, Superintendent of Motive Power, of the Chicago, Milwaukee & St. Paul Ry., by Mr. J. F. DeVoy, Mechanical Engineer of that road, and was built at the railway company's shops at West Milwaukee, Wis., under the supervision of Mr. J. J. Hennessey, Master Car Builder. These cars were designed and built specially for the transportation of the combined frame and slides of a horizontal rolling mill engine for the Carnegie Steel Co.'s plant at Sharon, Pa. This single piece weighed about 133 tons in the rough casting, and when finished ready for shipment weighed over 100 tons. The pattern for this great casting was 32 ft. long, 11 ft. wide and 10 ft. high, while the casting pit inside at the foundry was 40 × 15 × 11 ft.; the pouring of the metal was done in 8 to 10 minutes by four 25-ton ladles, one 13-ton ladle, and four 5-ton ladles.

The car, Figs. 1 and 2, consists of a steel underframe, each bolster of which rests on the middle of a cradle or distributing frame; each end of each of these frames rests upon the bolster of a four-wheel truck. The trucks are of the railway company's standard design for 100,000-lb. freight cars. Each pair of trucks with its cradle forms a compound truck, the cradle swivelling under the underframe and the trucks swivelling independently under the ends of the cradle. The cradle consists of two heavy hammered-iron side bars or equalizers, A, shown in detail in Fig. 3, and carrying between them a cast steel bolster, B, at the middle and a similar but smaller bolster, C, at each end. These end bolsters rest on the truck bolsters D, and have the usual center-plate connections. Upon the main or middle bolster is seated the body bolster, E, of the car body or underframe, a large and heavy center-plate bearing being fitted between them.

The underframing is of very simple design, and is lighter than in some other cars of less capacity, described below. There are four sills of 15-in. I-beams, and end sills of 15-in. channels. Heavy steel struts are riveted between the two center sills, and 8-in. channels between the center and side sills. The corners are reinforced by ½-in. plates riveted to the top flanges of the side and end sills, and by diagonals formed of plates 1 × 8 ins. placed vertically and running from the center sills to the end sills. Longitudinal timbers of oak, 4 × 4 ins., rest upon the transverse 8-in. channels and support a floor or deck of 2½-in. planks. The body bolster, Fig. 4, is very heavy and consists of two transverse frames, as shown by the plan and cross section. The top member of each is a plate 1 × 10 ins., laid across the center sills, and having the ends bent down to fit against the webs of the side sills, to which they are riveted; the lower member is similarly fitted at the ends, and is then bent down to pass under the center sills, being stiffened by other diagonal plates as shown.

FIG. 1. 100-TON FLAT CAR WITH FOUR TRUCKS; ALLIS-CHALMERS CO.

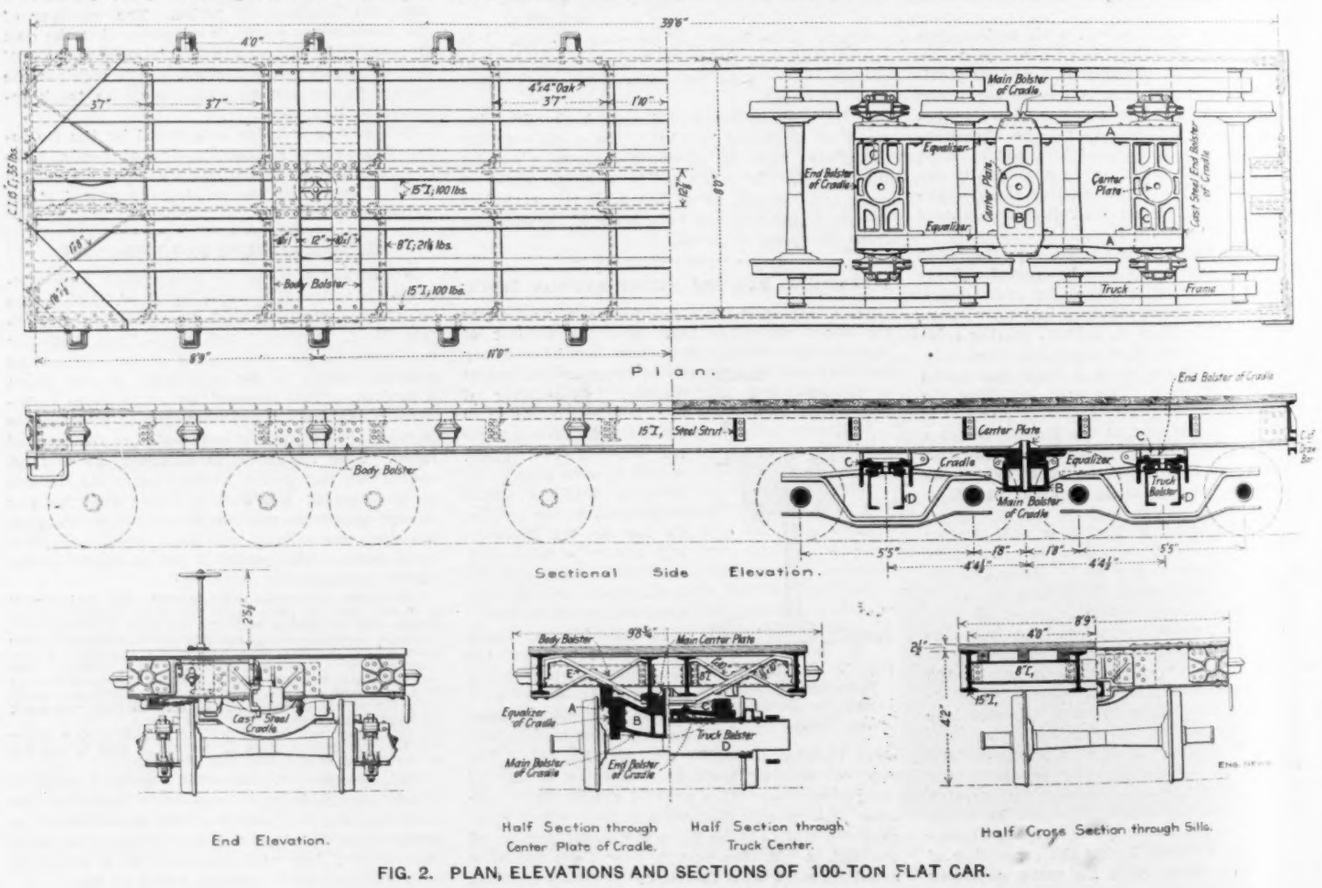


FIG. 2. PLAN, ELEVATIONS AND SECTIONS OF 100-TON FLAT CAR.

The principal dimensions of this and some other large flat cars are tabulated later on.

87-TON CAR: PENNSYLVANIA R. R.

This car, of 175,000 lbs. maximum capacity, is of peculiar design, being intended to carry shipments of castings, etc., which would exceed clearance limits if loaded on the floor of an ordinary car, and for this purpose it is made with a central well or opening 26 ft. 6 ins. long and 7 ft. wide. There is no floor beneath this opening, the vertical and lateral stresses being carried directly by the sides. Between the bolsters the frame consists simply of two box girders, each formed of a pair of 15-in. channels with top and bottom cover plates. The outer channels extend to the end sills, which are similar channels. The bolster is also of box section, with a pair of 12-in. channels, and two short 12-in. channels extending from the bolster to the end sill form the draft sills. Diagonal braces extend from the ends of the bolster to the ends of the draft sills, and a ¼-in. deck plate covers the entire framing between the bolster and the end sill. The construction is clearly showin in the drawing, Fig. 5.

The enormous load is carried entirely by a pair of four-wheel trucks; these have diamond frames and steel bolsters of box section, with a nest of coil springs under each end of the bolster in the usual way. The wheels are 33 ins. diameter, with cast-steel plate centers and steel tires, and the axles have journals 5½ × 10 ins. With the maximum load and an equal distribution of the load, each wheel will carry about 27,288 lbs. There are four of these cars in service, all of which were built in 1905 at the railway shops at Altoona, Pa., according to the designs of the Motive Power Department. In our issue of April 19, 1906, we referred to an English 50-ton car for carrying a cast-steel stern-post of immense size; this car has the plate girder sills and entire underframe dropped between the trucks so as to be within a few inches of the rail, thus effecting the same object as the "well" in the car above described. Another car with a "well" is noted further on.

75-TON CAR: PITTSBURG & LAKE ERIE RY.

In 1905, this road built at its shops at McKees Rocks (Pittsburg) two steel flat cars for the special purpose of transporting large and heavy castings of irregular shape. They were designed by Mr. L. H. Turner, Superintendent of Motive Power. An enquiry was made as to the largest casting made at the various Pittsburg works, and the cars were designed to handle the maximum weight and size. Two special points had to be provided for: First, the floor of the car must be kept within about 3 ft. 6 ins. from the rails, in order to give the necessary clearance with loads of the maximum height; for this reason the bolsters are comparatively shallow, but correspondingly heavy, while 26-in. wheels are used instead of the ordinary 33-in. freight car wheel. Second, a large proportion of the load might be concentrated upon the middle of the floor, and the car is therefore designed to carry its full 75-ton load on a comparatively small area at this point, so that its actual capacity would be considerably higher for a load distributed over a larger area. Records furnished us by the railway company show the following loads carried by these cars: crank shaft and gear rim, a little over 150,000 lbs. (car hauled around a curve of 300 ft. radius); machinery, 141,450 lbs. and 121,000 lbs.; crank shaft, 120,000 lbs., etc.

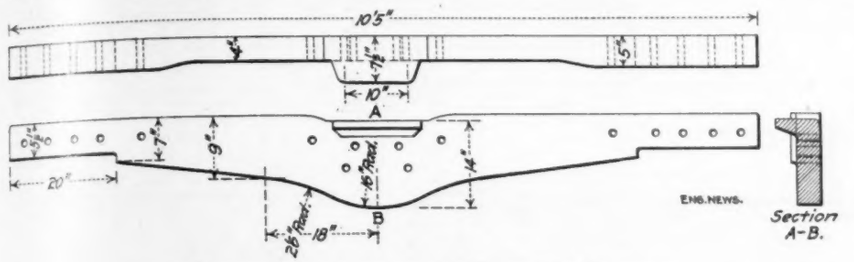


FIG. 3. SIDE FRAMES OF CRADLE OF 100-TON FLAT CAR.

The framing is of great strength and stiffness, and is clearly shown in Fig. 6. The side sills are of plate girder construction, connected by steel channel end sills and by the body bolsters. These latter are the full depth of the sills and are of box section, built up of angles and plates. The bolster and its connections are further reinforced by a ½-in. plate underneath, to which the bolster and four inner sills are riveted. These inner sills are similar to the side sills, but extend only between the bolsters; beyond the bolsters and in line with the sills are four 13-in. channels extending to the end sills. Diagonals of 8-in. channels extend from the intermediate sills to the end sills, and heavy gusset plates are used at the corners of the frame, while angle brackets are used for the connections of the sills and bolsters. Transverse strength of the framing is given by malleable iron castings between the closely spaced center and intermediate sills, and by 10-in. channels between the intermediate and side sills, while the entire underframe is stiffened by a deck ¼-in plates, with lap joints at the transverse seams. The deck is covered with a wearing floor of 1¾-in. plank. To provide for securing the loads, there are stake pockets riveted to the side sills, and 1⅛-in. holes through the floor for bolts and fastenings. The draft rigging is fitted between the center sills.

The load is carried by two trucks, Fig. 7, having frames of the arch bar or diamond pattern, with steel channel spring planks and cast steel bolsters. At each end of the bolster are four coil springs, 5½ ins. diameter and 6 ins. high, each having a double coil of a bar ¾ × 1¼ ins. The bars of the frame are very heavy, all being 6 ins. wide; 1¾ and 1⅝-in. thick for the upper and lower arch bars, and ⅞-in. for the tie bar. Steel-tired 26-in. wheels are used, the small diameter being adopted in order to keep the floor as low as possible (as already noted).

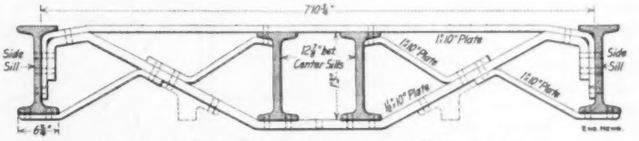


FIG. 4. BODY BOLSTER OF 100-TON FLAT CAR.

60-TON CAR: PENNSYLVANIA R. R.

This car has an ordinary flat floor, instead of the open well of the 87-ton car above described, but although it is of lighter capacity than the latter it is carried upon four trucks instead of two, as shown in Fig. 8. The cars of this type were designed specially for carrying reels or spools of wire cables, the length of these reels being about 17 ft. The underframe consists of

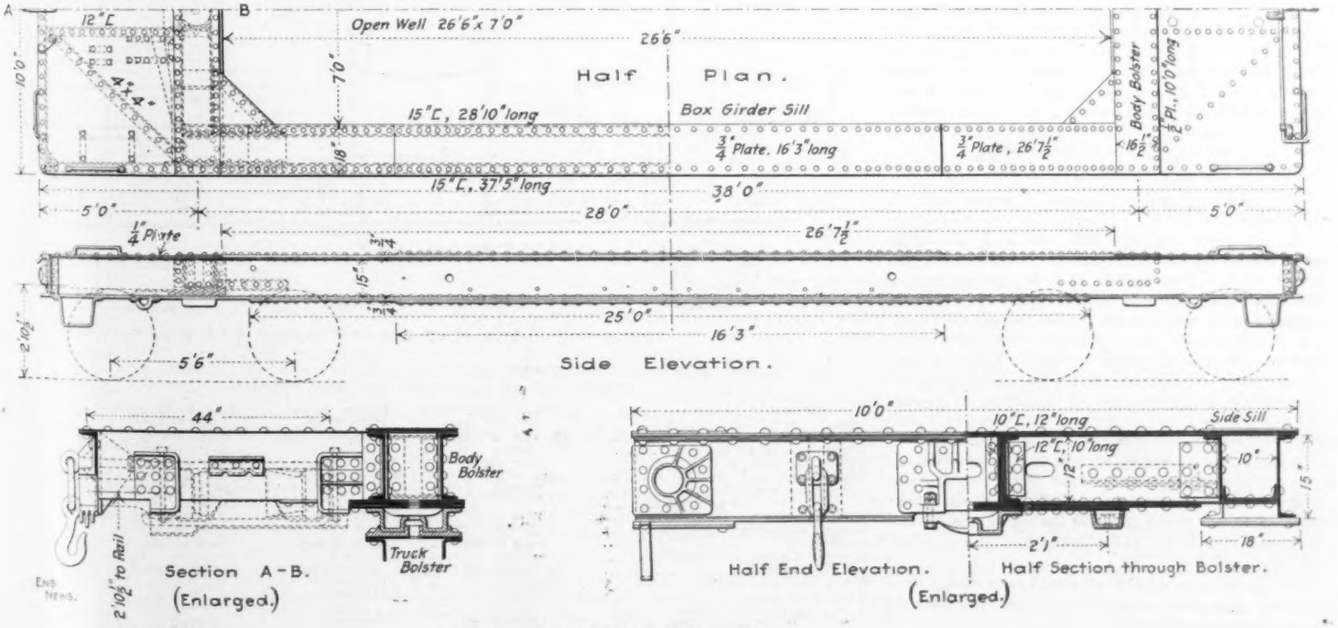


FIG. 5. 87-TON FLAT CAR; PENNSYLVANIA R. R.

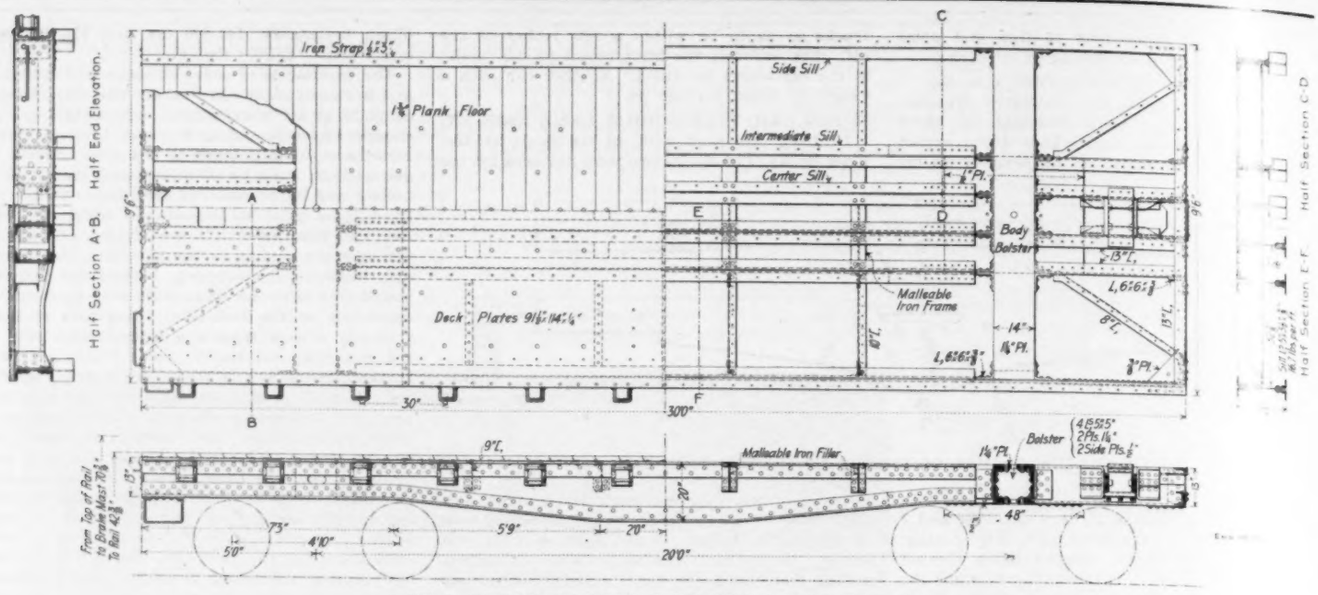


FIG 6. 75-TON FLAT CAR; PITTSBURG & LAKE ERIE RY.

two fish-belly plate-girder sills (with stiffener angles at frequent intervals), two steel plate end sills (with wooden bumper beams attached), and a series of transverse 9-in. I-beams fitted between the side sills, being secured to the girder webs by heavy angle brackets. These beams are spaced about 16 ins. to 20 ins. c. to c., but at the two points where the heads of the reels are supported, there are four beams grouped together, the two outer ones 4 ins., and the two inner ones 7 ins. c to c. The bolsters are very heavy, of box section, each composed of four channels and two web plates, together with top and bottom cover plates. From the bolster, two draft sills of 9-in. channels extend to the end sill, and diagonals run from the ends of the bolster to the end sill. Between the bolsters, the floor is composed of ½-in. transverse deck plates, 4 ft. wide; but at the ends the floor is of oak planking.

Each body bolster rests upon the bolster of a distributing frame, having 2-in. side plates carrying the main bolster already referred to, and two end bolsters 8 ft. 3 ins. c. to c. These latter have center bearings which in turn rest upon the bolsters of a pair of trucks. The truck bolsters consist of 12 × 12-in. oak timbers trussed with 1¼-in. rods, and are sandwiched between steel channel transoms. The trucks have diamond frames, 33-in. cast iron wheels, and journals 4 × 8 ins. There are four of these cars in service, designed and built at Altoona in 1888. Two of these, loaded with an immense chord member for the Blackwell's Island cantilever bridge at New York, were exhibited at the railway appliance exhibition in connection with the International Railway Congress at Washington last year.

60-TON CARS: GENERAL ELECTRIC CO.

For handling the armatures of generators of 8,000 and 5,000 KW. a special flat car has been built, with plate girder side sills and having a central well as in the 87-ton car of the Pennsylvania R. R. The well is 15 × 8 ft., and has a casing of steel plate to protect the load, which is suspended by straps from timber trusses mounted on the side sills and connected by transverse trusses. The well casing comes to within 6 ins. of the level of the rail head. The armatures of the 5,000-KW. generators for the Fisk St. power station of the Chicago Edison Co. weigh 111,000 lbs., and were each shipped on the General Electric Co.'s 50-ton flat cars, but the armatures of the 5,000-KW. generators for the Port Morris and Yonkers power stations of the New York Central R. R. weigh 122,000 lbs., and are 12 ft. diameter and 8 ft. wide; for these, the special car was built.

The dimensions of the principal cars above described, and their weights, etc., are tabulated in the accompanying table.

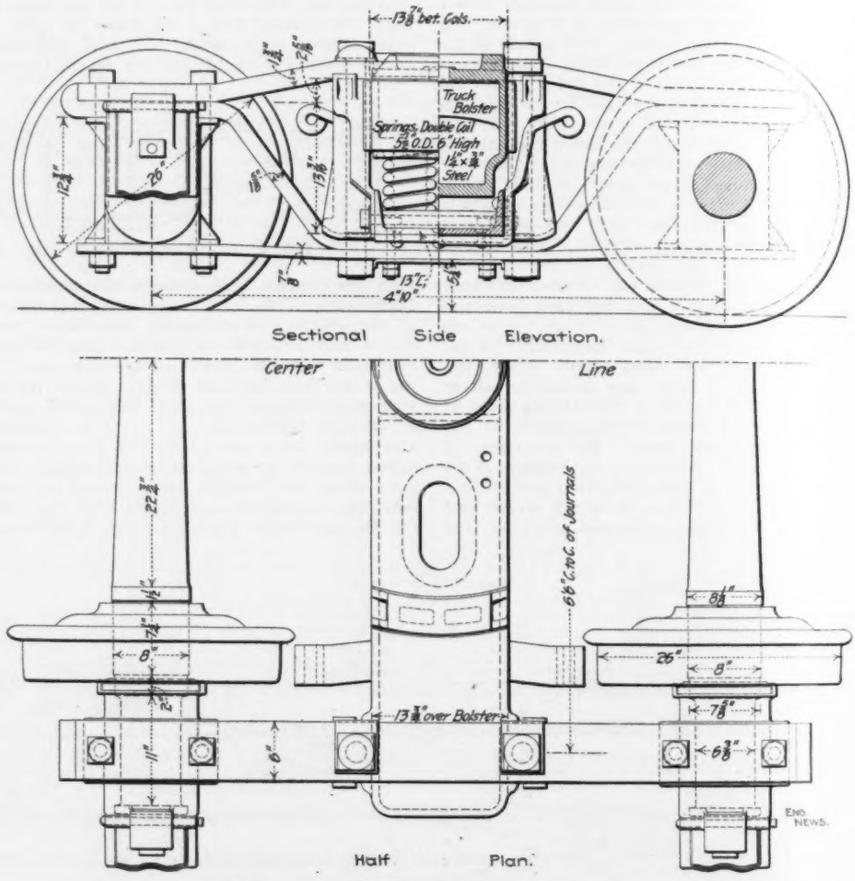

13⅜" bet. Cols.
Truck Bolster
Springs, Double Coil 5" O.D. 6" High 1½ x ⅜" Steel
Sectional Side Elevation.
Center Line
6'6" c. to c. of Journals
13¾" over Bolster
Half Plan.

FIG. 7. TRUCK FOR 75-TON FLAT CAR; PITTSBURG & LAKE ERIE RY.

DIMENSIONS OF FLAT CARS FOR HEAVY LOADS.

Railway.	Allis-Chalmers Co.	Penna. R. R.	P. & L. E. Ry.	Penna. R. R.
Capacity, rated	200,000 lbs.	175,000 lbs.	150,000 lbs.	120,000 lbs.
Length over end sills	40 ft. 2 ins.	38 ft. 0 ins.	30 ft. 0 ins.	30 ft. 0 ins.
Width over side sills	8 " 9 "	10 " 0 "	9 " 6 "	7 " 9 "
Height, rail to floor	4 " 4⅛ "	3 " 10⅛ "	3 " 6⅞ "	4 " 7¾ "
Truck wheelbase	(4) 5 " 5 "	(2) 5 " 6 "	(2) 4 " 10 "	(4) 5 " 0 "
Trucks, distance c to c	22 " 0 "	28 " 0 "	20 " 0 "	21 " 9 "
" " of each pair	8 " 9 "	.....	.....	8 " 3 "
Total wheelbase	36 " 2 "	33 " 6 "	24 " 10 "	35 " 0 "
Wheels, diameter	2 " 9 "	2 " 9 "	2 " 2 "	2 " 9 "
Journals	5⅛ x 10 ins.	5¾ x 10 ins.	6¾ x 11 ins.	4 x 8 ins.
Number of axles	8	4	4	8
Weight of car	72,800 lbs.	43,300 lbs.	48,200 lbs.	51,800 lbs.
Weight and max. load	218,300 "	218,300 "	198,200 "	171,800 "
Weight, per wheel	27,288 "	27,288 "	24,774 "	10,738 "
" per ft. of wheelbase	6,516 "	6,516 "	7,992 "	4,909 "
" " " truck wheelbase	19,845 "	19,845 "	20,646 "	8,590 "

INCREASED TERMINAL FACILITIES FOR THE PANAMA RAILWAY.

The ability of the Panama Railway to properly handle the great quantity of freight for the canal works, in addition to the regular through or intercoastal freight, has been discussed several times. We learn from information which we have recently received from Mr. W. G. Bierd, Superintendent of the Panama Railway, it appears that the new administration has taken steps to provide adequate rail and water facilities for efficiently handling both the through and canal traffic.

On the Atlantic side there are six wharves and piers, which will accommodate 13 vessels of any size. This includes berths for six vessels with ordinary cargo such as requires to be housed from the weather, and seven berths for vessels with such cargo as does not need shelter and is awkward to handle on piers having sheds; this includes rails, ties, piling, lumber, cars, machinery, etc. Some of these docks were built many years ago, but three have been built within the past few months, and are being equipped with modern freight-handling machinery, cranes, etc. Dredging has been carried on so that vessels of 25-ft. draft (which is the maximum at this port) can go to any docks in Colon or Cristobal harbors.

On the Pacific side there are two old piers, practically worn out; these were constructed for handling cargo from lighters and are in the old Panama harbor. No vessels enter this harbor, as they remain in the bay and discharge their cargo into lighters or barges, which are towed to the piers. At La Boca, in the port of Ancon, two miles from Panama, there is a steel dock or pier 900 ft. long, which has been in use for about seven years, and accommodates two of the largest vessels. Within the past six months a new dock 800 ft. long has been completed, and the old wharf extended 350 ft., so that five vessels in all can be berthed, independent of the lighterage to the old wharves at Panama.

The rail terminals consist of two old yards; that at Colon has track room for about 300 small cars, but the capacity has been lessened by the introduction of newer and larger cars. In addition to the docks there is one freight house, with a capacity of about 150 car loads. There is about the same yard accommodation at Panama and La Boca, but the cars on hand crowd the running and lead tracks, which should be kept open for the movement of trains. At Colon, however, a complete terminal on modern plans is under construction, and includes a machine shop, round house, coaling station, water station and a freight yard capable of handling the business for a number of years. Similar terminal facilities, but with a smaller machine shop, will be constructed on the Pacific side. The railway is being double-tracked, and the new equipment includes 25 locomotives, 300 flat cars and 500 box cars. Further equipment has been ordered, and while this is intended for the canal construction service it will assist in the general movement of traffic.

On the Atlantic side there are ten regular steamer lines, with sailings at intervals of from five days to a month, and on an average there are always five regular steamers and four tramp steamers in port, the latter including vessels with material for the canal. On the Pacific side there are three regular steamer lines, and the average number of vessels in port at any time includes three regular and two tramp steamers.

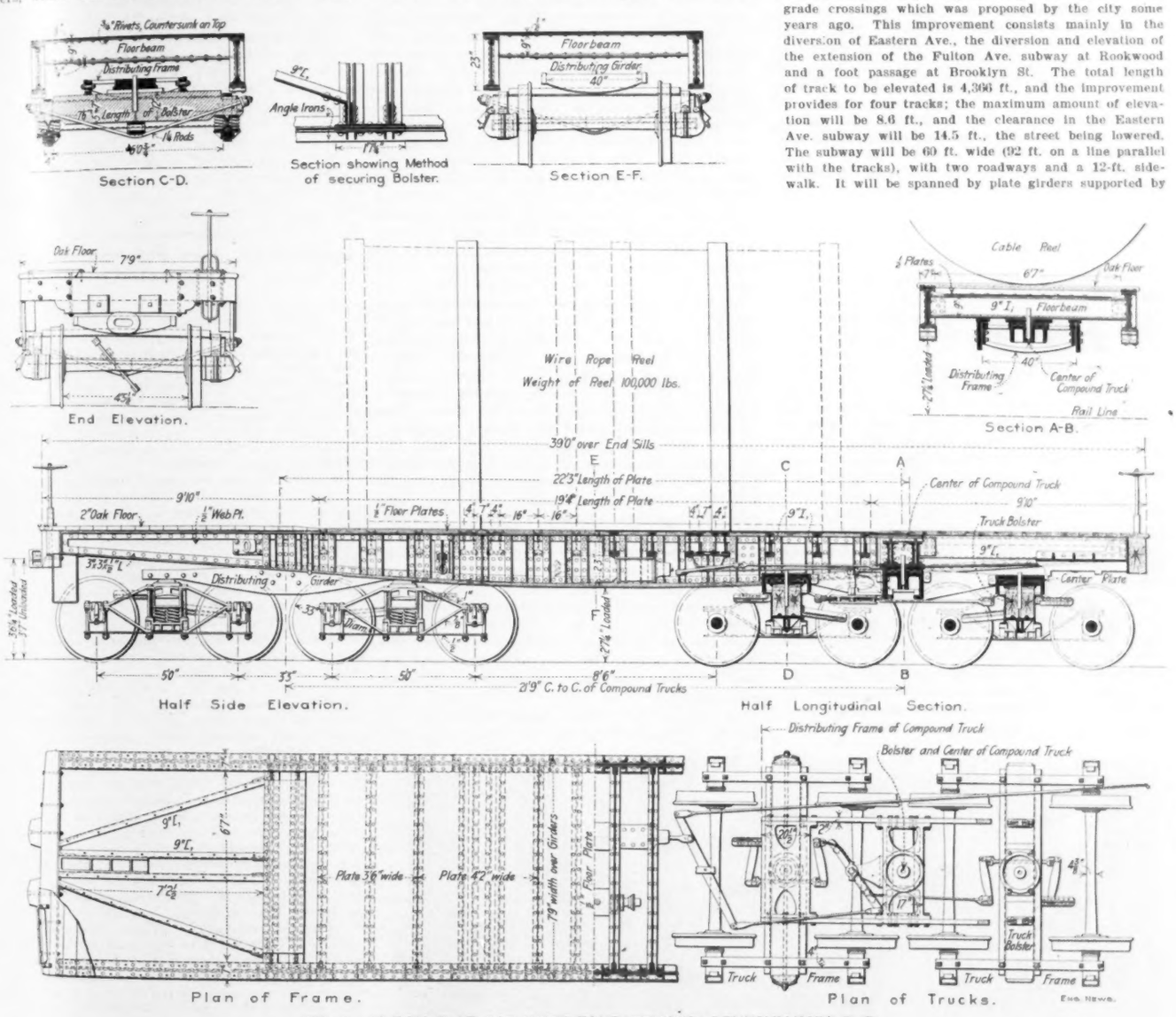


FIG. 8. 60-TON FLAT CAR WITH FOUR TRUCKS; PENNSYLVANIA R. R.

TRACK ELEVATION at Cincinnati, Ohio, is about to be commenced, and the first piece of work to be undertaken marks the beginning of the general elimination of grade crossings which was proposed by the city some years ago. This improvement consists mainly in the diversion of Eastern Ave., the diversion and elevation of the extension of the Fulton Ave. subway at Rookwood and a foot passage at Brooklyn St. The total length of track to be elevated is 4,366 ft., and the improvement provides for four tracks; the maximum amount of elevation will be 8.6 ft., and the clearance in the Eastern Ave. subway will be 14.5 ft., the street being lowered. The subway will be 60 ft. wide (92 ft. on a line parallel with the tracks), with two roadways and a 12-ft. sidewalk. It will be spanned by plate girders supported by the abutments and a central row of columns. Eastern Ave. will stop at Litherbury St., cross under the tracks by the skew subway and then return to its original line by an extension in line with Fulton St. Mr. J. P. Bouscaren is Superintendent of the Department of Track Elevation and Subways.

THE FOUNDATIONS OF THE COUNTY BUILDING, Chicago, will consist of 126 cylindrical concrete piers, resting upon bed rock at an average depth of 115 ft. below the street level, and varying from 4 ft. to 12 ft. in diameter. Open wells with plank sheathing were put down in the way now generally employed for the foundations of large buildings in Chicago, the wells being then filled with a concrete composed of 1 part Portland cement, 3 parts sand and 5 parts broken stone. A large part of the stone from the old building was broken and crushed on the site and used in making the concrete foundations for the new building.

PROBLEMS IN BURNING PORTLAND CEMENT WITH LONG ROTARY KILNS.

By Carleton Ellis.*

The present tendency towards the lengthening of 60 and 80 ft. rotary kilns for cement burning to 100, 110, 125 and even 150 ft. is indicative of the desire on the part of the cement manufacturer to gain greater fuel economy and output even though the changes require the complete abolition of his kiln room and the construction of practically a new cement burning equipment, all at great expense. In view of such a tendency it is hoped that this article, which has for its object the discussion of the "long" kiln and its economies, may prove apropos.

Much has been expected of the "long" kiln and it is well known that results have not equalled expectations. Predicted economies and outputs have not been realized. Just why this is so is a question one frequently encounters. To this the writer would make answer that the engineers and chemists who have furnished us with prospective efficiencies and outputs of "long" kilns, have in a large measure used the operation factors of the 60-ft. kiln as a basis for computations, and consequently have been led into errors of considerable magnitude in their predictions, as will presently be pointed out.

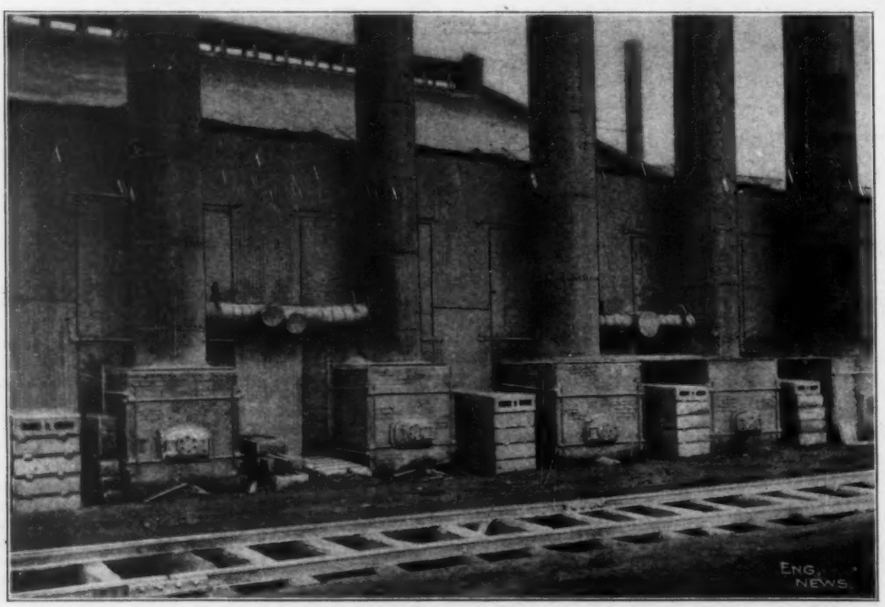
The incorrectness of their predictions seems in a large measure to be due to failure to consider a most important factor in cement burning, namely, the *quality* of the calcining flame. The cement kiln has to perform two operations which are essentially quite distinct, chemically and otherwise, one from the other. In the upper part of the kiln efficient calcination should take place, that is carbon dioxide contained in the limestone should be well driven off in order to fit the material for the subsequent changes which it is to undergo in the clinkering zone. Calcining calls for a relatively low temperature as compared with clinkering and for a heat which in steel furnace practice is termed a "soaking heat." Only by having a flame of the peculiar quality described as "soaking" can calcination be made rapid and thorough. With the usual methods of burning cement employing powdered coal and ordinary air the needed "soaking" flame is not properly produced in the region of the kiln devoted to calcination, even in the case of the 60-ft. kiln. With longer kilns the difficulty is much aggravated and to this imperfect flame development the writer largely attributes the failure of the long kiln to fulfill the prophesies of its promoters. However, inventors have been busy in the field, and already certain methods have been put to practical use which permit of a betterment of operation. Of these the one which unquestionably is most promising is the Eldred system, named for the inventor, Mr. Byron E. Eldred.

In studying flame action in the cement kiln Mr. Eldred determined the need of a "soaking" flame in the calcining zone, and after considerable experiment found a solution of the problem. He ascertained that ordinary air for combustion was not suitable for the production of a "soaking" flame, since oxygen was present in too great a proportion. Thereupon he diluted the air with waste stack gases and found the "soaking" flame to develop satisfactorily. In the "soaking" heat thereby obtained in the upper portion of the kiln the calcining process progressed with marked rapidity and thoroughness. In this manner the output of the kiln was increased and fuel consumption reduced. Furthermore the effective flame was lengthened by the employment of the stack gases. This in itself is important to the user of "long" kilns. Here, however, let the writer anticipate a misapprehension which may arise. Flame is often seen at the top of cement kiln stacks when ordinary air is used for combustion when the proportion of air to fuel is not properly adjusted. In this case we have a poor species of the "long" flame. Such a flame is not effective for calcination, as it does not produce a "soaking" heat. Heat quality is just as important as heat quantity. The Eldred system appears to provide heat of the right quality and a practical method of flame control. The system causes the barrel of the kiln in the calcining region to fill with a well developed "soaking" flame. The long kiln operated under this system should approach the early predictions of long kiln efficiencies, which up to now have not been fulfilled.

The Eldred method likewise disposes of the difficulties due to the formation of "rings." The long kiln is especially prone to "ringing" troubles. Stack gas dilution of the air seems to be the only efficacious remedy known at present. Stack gas is peculiar in this respect. Too great an excess of stack gas has been found to cause "rings" just as badly even as ordinary air does, although not in precisely the same region of the kiln. With the correct proportion of air and stack gas "rings" are practically done away with and the long kiln shows an improved operation in more ways than one.

At one of the cement plants employing the Eldred system exclusively, connections are made to the stacks as shown in the accompanying illustration. Four stacks are tapped for waste gases. The gases are brought back to the foot of the kilns and admixed with air in proper amount. This mixture of air and waste gases, together with coal dust, is fed into the kilns and ignited. The flame produced is advantageously directed upon the material to derive the obvious economy which results from the application of an impinging flame.

*60 Wall St., New York City.



VIEW OF CHIMNEYS OF A ROTARY KILN PORTLAND CEMENT PLANT EQUIPPED FOR THE USE OF STACK GASES TO REDUCE INTENSITY OF COMBUSTION.
(The view shows pipes by which gases are taken from the stacks and returned to the mouth of the kilns.)

[By "soaking" flame we believe is generally meant a reducing or non-oxidizing flame. In steel furnace practice such a flame is often desired to prevent oxidation of the charge. The same reason does not obtain in a cement kiln, since the flame operates by its heat alone and not by chemical action. It is apparent, however, that a small volume of intensely heated gases or a larger volume of gas at a lower temperature may be discharged into the mouths of a cement kiln and effect quite different results. As we understand it, the latter effect is produced when a mixture of air and stack gas is used for combustion instead of pure air; and the results obtained, we are informed, are very satisfactory.—Ed. Eng. News.]

ARCHITECTURAL FORM AND FINISH IN CONCRETE CONSTRUCTION.*

By William L. Price.

I turn to the possibilities of the material architecturally. I cannot see much sense in the use of concrete as a substitute for block building material, although it will probably have its place if it is frankly treated as concrete and not as imitation stone. But the possibilities of design in concrete used this way are those of its competing materials, stone, brick and terra cotta, so that I shall not dwell upon that, but try to point out something of what seems to me to be its greater possibility as a plastic material.

In block building, whether of stone, brick or other material, the joints are an essential element of building, and as such should become an essential element of design to be accentuated rather than hidden, and in all characteristic and good architectural design you will find recognition of this fact. Take, for instance, any of the classic orders or their modifications in the Renaissance, and you will find a frank succession of blocks and columns set upon plinths, or directly on basement wall, cap, abacus, frieze and cornice, all built up stone upon stone with major joints marked by moldings, bands and ornament, a logical, built structure. But if we attempt to follow such a system of design in a plastic material, or even a material like wood, the results are disastrous to true architecture. The design becomes a matter of external form, not of the true expression of methods and materials used. Concrete is built with shovel and trowel, and its proper ornamentation should be either cast in molds as built or such as can be run or fashioned on the work, with the addition of such color ornament as may be obtained by the use of terra cotta or other protecting material used as wall copings, roofs, pier caps, etc., and such other flat color ornamentation as may be produced by the use of tiles, marble, glass or other material which is evidently applied to the surface. It is evident that this would and should make a wide departure from classic forms and accepted styles, that it means in fact a new architecture, although it will not be necessary to abandon all precedent. We shall want walls, windows and doors in any case, and must learn to build them in their accepted forms. But in a material so plastic the forms of openings and moldings may be expected to vary much from those necessary to an architecture dependent on arches and lintels. There is more to be learned in the Spanish, or Californian and Mexican varieties of Spanish, than any other accepted type. Their plastered walls, tile roofs and wall copings suggest concrete more than they do brick, and their domes and curved pediments are already suggestive of plastic rather than block construction.

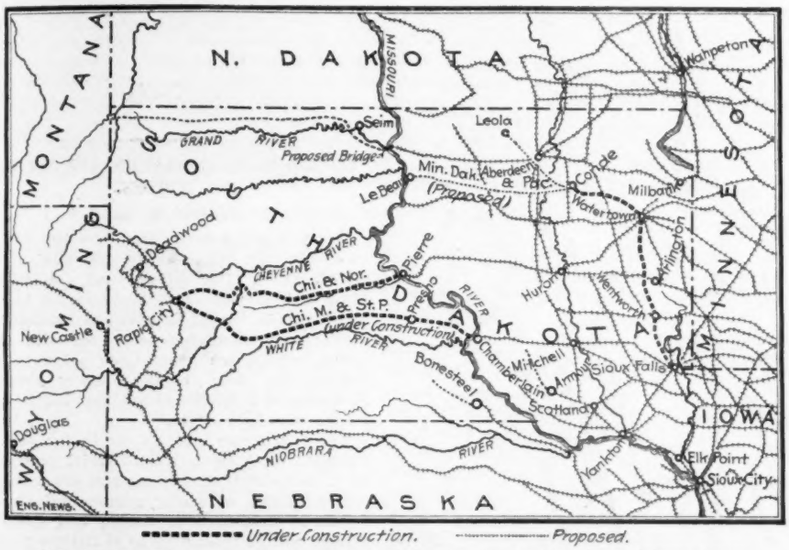
I may perhaps be permitted to refer to the Blenheim Hotel as an example of an attempt to carry out some of these thoughts. At least there is no suggestion of built structure in its simple wall openings, its exceedingly few and simple moldings, and its total lack of cornices. We have distinctly tried in it to use a solid wall, pierced by the simplest of openings, in an effort to reduce to a minimum the chopped-up appearance common with buildings that of necessity have many windows and small unbroken wall spaces. We have attempted, even where the wall was broken still further by bay windows, to

*Extract from a paper read before the March quarterly meeting of the Association of American Portland Cement Manufacturers, held at the Bellevue-Stratford Hotel, Philadelphia, Pa., and published by that association as "Bulletin No. 2."

preserve this feel of wall and have used the shadows thrown upon this broken surface by balconies, to give the relief usually obtained by ornamented cornices, and with the addition of a tile roof and some beautiful color obtained with Mercer tile, we have secured sufficient color and variety to make a building essentially plain in wall surface, give a sense of richness not always obtained by the use of elaborate and expensive ornamental work in stone or terra cotta, and the use of a moderate amount of terra cotta where required for sills, copings and other wall protection, has been made unusually important by modeling it in interesting and appropriate sea forms and coloring it a light green, by a glaze which has the additional advantage of destroying any semblance of stone and giving it a plastic character that seems appropriate to modeled ornament. It is along the line of simple and direct expression of the purpose and mode of construction of building that architecture grows when it is really growing, and cement in its manifold possibilities spreads before us a new field for the imaginative designer

RAILROAD EXTENSIONS IN SOUTH DAKOTA.

The accompanying map will give a general idea of the extent of railroad extensions, now under construction or proposed, in the State of South Dakota. As shown the Chicago & Northwestern Ry. are building a line from Pierre to Rapid City, while the Chicago, Milwaukee & St. Paul Ry. are connecting Rapid City with Chamberlin. These extensions, together with those connecting Sioux Falls and Watertown and the



Under Construction. ——— Proposed.

MAP OF SOUTH DAKOTA, SHOWING CONTEMPLATED RAILROAD EXTENSIONS.

extensions of the lines from Bonesteel and from Armour, make a grand total of more than 1,000 miles of railways to be built in the state this year. This figure does not include the proposed Minnesota, Dakota & Pacific R. R., an extension of the Minneapolis & St. Louis R. R., which is projected to run from Watertown to Le Beau, with a branch from Conde to Leola, nor the proposed Chicago, Milwaukee & St. Paul Ry. extension from Evarts to the Montana line. These two lines will aggregate about 400 miles of track, thus making a grand total of some 1,400 miles of new road, either proposed or now under construction.

SPECIFICATIONS FOR THE PROTECTION OF BUILDINGS AGAINST LIGHTNING.*

1.—WHERE ADVISABLE.

Protection against lightning is advisable on country buildings, on isolated buildings, and on all buildings wherever located having elevated features such as tall chimneys, steeples, high peaked or gable roofs and flag poles.

2.—GENERAL SUGGESTIONS FOR INSTALLATION.

a. One rod with proper air and earth terminal is recommended for unit of ground area as follows:

Flat or peaked roofs of metal, one for each 3,000 sq. ft. of ground area.

Flat or peaked roofs other than metal, one for each 1,600 sq. ft. of ground area.

NOTE 1—Air terminals should never be more than 50 ft. apart. Ordinary type flat or peaked metal roof approximately 60 × 60 ft. ground area or same type other than metal, approximately 40 × 40 ft. ground area, will require one rod and earth terminal, but sharp corners wet with rain, such as gables, dormers and wings, diminish resistance and may require protection in greater proportion to area.

NOTE 2—A low, broad building of greater area than 75 × 100 ft. can best be protected by an additional rod through the center of the building.

b. The air terminal to be placed at the highest point of the roof or structure. Where there are two or more gables or other projections above the roof of equal or nearly equal height, each to have an air terminal, and all to be bonded together over the high part of the roof to make the system a unit.

NOTE 3—More than one air terminal can be connected with the same ground by the regular conductor, provided other conditions in these rules are not violated. See Rule 5, a.

c. All exterior metal work to be connected with the lightning rod system below the line of the metal work itself or be separately grounded by regular conductor. This includes metal roofs, gutters, ventilators, railings, chimney hoods and stacks.

d. All inferior masses of metal, such as girders, beams, water piping and any structural iron or steel, but under no consideration gas piping, to be securely connected to the system at their highest and lowest points, the connecting bonds being the regular conductor. It should be borne in mind that conductors and bonds throughout their entire course should always incline downward.

NOTE 4—Where a building contains gas piping, the iron pipe on both sides of the gas meter to be securely bonded around the meter by conductor, being careful to make secure electrical connections between the pipe and bond. See Rule 6, a.

e. Where trees stand so close to a building that branches overhang or approach very close to the roof, a conductor with proper earth terminal to extend along the trunk of each tree to near the highest branch top, fastened by a band around the branch or trunk and equipped with a cluster of points. If extreme protection in such cases is desired, wires may be strung from tree to tree across the roof of a building, with sufficient slack to permit of trees swaying and all connected together. In either case the building should also be equipped with proper lightning rod.

NOTE 5—If wires are strung across a building from tree to tree they should be not smaller than No. 6 B.& S.

3.—MATERIALS.

a. Conductors may be made of soft copper in either sheet or tape form, or in form of stranded cable, weighing in each form not less than 6 ounces per foot. Where cable form is used no single copper wire to be less than No. 12 B. & S.

NOTE—One-inch iron rod can be used to connect iron ground with copper conductor, the conductor terminating above the surface of the ground.

b. Conductors may be made of iron in either sheet or tape form, or in cross section representing "star" shape, weighing in each form not less than 2¼ lbs. per foot. Iron, when used in any form, must be thoroughly galvanized to prevent corrosion, and may be also painted if desired.

4.—AIR TERMINALS.

a. To be rods of iron or copper not less than ⅝-in. in diameter with point cone shaped, and height of cone equal to the radius of the base.

b. One foot below the point there should be a casting holding four copper points, each 6 ins. long and ¼-in. in diameter, or a group of points may be placed on the end of the terminal.

c. Large chimneys should have a band of copper or iron not smaller than the conductor around the top below the corbeling with terminals securely attached thereto extending 3 ft. above the chimney. The terminals to be placed at intervals of not exceeding 4 ft. along the circumference of the chimney; each terminal to be connected individually with the band around the chimney.

d. All metal chimneys or stacks to be thoroughly grounded.

e. Terminals should extend not less than 3 ft. above flat or peaked roofs or chimneys and be firmly secured in an upright position.

5.—CONDUCTORS BETWEEN AIR TERMINALS AND GROUND.

a. All joints to be made mechanically and electrically secure and then soldered.

b. To be run down side of building where best ground is obtainable, preferably on the side most exposed to rain.

c. Not to be run nearer than 5 ft. to interior piping unless absolutely unavoidable.

d. To be run as straight as possible, avoiding all turns of radius less than 1 ft. and to incline downward throughout its entire course.

e. In case of a chimney other than iron, 50 ft. high, two conductors on opposite sides should be provided. Where a chimney is in excess of 50 ft. in height an additional conductor should be provided for each additional 50 ft. or fraction thereof, spacing the conductors at equal intervals around the circumference of the chimney.

NOTE—Added protection can be secured by providing extra bands around the chimney at intervals of 25 to 50 ft., all such bands to be securely connected to all conductors.

f. Should never be insulated but fastened securely to the surface to be protected by clamps of same kind of metal and of sufficient strength in mechanical application to prevent conductors from working loose, at the same time allowing for expansion of the metal.

g. Must never run through iron pipes.

6.—CONNECTIONS.

a. With iron piping or castings, preferably to be made by screwing a brass plug into same and fastening conductors securely to it, then soldering. Another method is by using a soft metal clamp having a cross section of not less than ¼-in. by 1 in., which will securely grip the pipe by means of tightening a machine screw or bolt not smaller than ¼-in. in diameter. The conductor to be soldered to a lug in this device.

b. With copper ground, by riveting and soldering, the connection then being coated with asphaltum paint.

7.—GROUNDING ON EARTH TERMINALS.

a. A copper plate, not less than 2 ft. by 3 ft. by 1-16-in. buried in permanently damp earth below the frost line and not less than 4 ft. below the surface, with 3 ins. of crushed coke or charcoal underneath, and the same material above to within 6 ins. of the surface of the ground.

b. An iron casting, so shaped as to have a number of pockets or cups facing upward, should have not less than 6 sq. ft. of surface. Should be buried in not less than 6 ins. of scrap metal and coke under, and 6 ins. over same.

c. A third method of grounding, which may be used if neither of the above is possible, is to dig a trench not less than 3 ft. long and 1 ft. wide, leading away from the building and deep enough to reach permanently damp earth, but not less than 4 ft. deep, and cover the bottom with a layer of scrap metal or well burned coke, about walnut size, in which a "star" shaped casting securely attached to conductor shall be imbedded.

d. Another very satisfactory method of grounding is to connect the earth terminals with municipal water pipes, and where such connections are permissible, connection can be made as specified under No. 6, by connecting into the bell at the joints or where piping is wrought iron, by the clamp, as specified.

e. An iron pipe not less than 10 ft. long, 2 ins. inside diameter and ¼-in. thick, perforated with ½-in. holes at intervals of 3 or 4 ins., or with slots ¼-in. by 10 ins. at intervals of 10 ins. A hole must be dug 10 ft. deep and not less than 6 ins. in diameter, the pipe placed in the center and the hole filled in with crushed coke or charcoal about pea size.

NOTE—A proper ground is absolutely essential and permanently damp earth is absolutely required. If same cannot be found at base of conductors, they should be extended underground (buried below the frost line in a wooden jacket) to a point where proper ground can be found. Where a 1-in. iron rod is used to connect conductor and ground, same need not be encased in a wooden jacket.

R. P. Barbour, B. E. Loomis, Fitzhugh Taylor, H. O. Lacount, Ralph Sweetland, W. S. Wensley, Committee on Lightning.

*Report of a Committee at the annual meeting of the National Fire Protection Association.

A NEW DUST-PREVENTING and dust-laying material for use on roads and streets was tried in Scotland last year, with results said to be promising. It consists of "an aqueous emulsion of wool-washing suds or wool-fat or wool-wax, with or without the addition thereto of a disinfecting oil," and may be applied to country roads, streets and railway beds by spraying. It is described as a by-product of a by-product; that is, after recovering the major part of the grease from wool washing wastes the remaining wool-grease, together with potash and soap fats, are saved for subsequent dilution with water and used for street or road sprinkling. It is said that the emulsion does not clog the spraying apparatus and that its hygroscopic qualities keep down dust for a long time. A U. S. patent (No. 813,389; Feb. 20, 1906) on the so-called "process" has been granted to Wm. Munro Sandison, of Ashfield, Ayton, Scotland, assignor of one-half interest to Mr. Herbert G. McKerrow, of H. G. McKerrow & Co., 31 State St., Boston, Mass. The trade name "Sandisize" has been adopted for the material.

DOCKS AND HARBOR WORKS of great extent are projected at Antwerp, Belgium, and will make this one of the largest and best equipped ports in the world. The city is on the river Scheldt, and while it has some docks its principal accommodation for shipping is at a quay or river wall 3½ miles long, and provided with railway tracks, power cranes, warehouses, etc. Immediately below the city the river makes a sharp loop, and it is proposed to make a cut-off or river diversion about 7 miles long. On this would be a quay 5½ miles long, making with the present quay a total length of 9 miles, on a curve. Behind the new wall is to be a broad channel 5 miles long, 825 ft. wide and 40 ft. deep, from which will open nine docks or slips, 3,960 ft. long and 660 ft. wide, with a depth of 40 ft. The double locks giving access to the channel or canal dock behind the quay will be 1,000 ft. long, subdivided by gates, and about 300 ft. wide over all; the depth will be 27 ft. on the sill at low water, or 40 ft. at high tide. One side of this channel would serve as a quay, parallel with that on the river front. In addition to this, the river below the city is to be improved to give a wider deep-water channel. The project has been authorized by the Belgian government, which will provide the necessary funds. It is estimated that the works will cost from $50,000,000 to $60,000,000 and require about ten years for complete construction.

NOVEL STEEL PIER CONSTRUCTION AT LOME, AFRICA

The small German colony of Togo on the west coast of Africa has, through its colonial government, recently completed a landing pier for deep water vessels at its principal port of Lome. This pier is of steel and is 304 m. (997 ft.) long, with a platform width of 8.85 m. (29.03 ft.) for 50 m. (164 ft.) at the outer end to form a landing stage and of 6 m. (19.68 ft.) for the remainder of the length to the shore. The landing stage is provided with traveling cranes for handling freight and a double line of railway tracks reaches to the shore. The pier platform is a plate girder structure carried on rocker bents supported on pile piers. It is the pile pier and rocker-bent construction that is of special interest.

The transverse section, Fig. 1, shows the arrangement of the piers, rocker bent and platform at each point of support. Each pier, as will be seen, consists of three piles arranged like a tripod and carrying a cap at the top as shown by Fig. 2. The rocker bent bearing on the pier cap is shown by Fig. 3. From the construction described it will be seen that the pier platform has a certain flexibility to resist shocks from vessels or waves. To limit this flexibility the inshore end of the pier is constructed as shown by Fig. 4, the masonry pier serving as a buffer block against inshore movement and the anchor resisting outshore movement.

The pile pier construction is notable chiefly for the novel form of steel pile used. The construction referred to is indicated by Figs. 5 and 6. The pile proper is a steel shell, 12 mm. thick and 25 cm. in diameter, provided with a shoe; surrounding this pile is another shell, also provided with a shoe in two parts b and p connected by small rivets. In construction the outer shell was first driven about 2 m. into the bottom, then the inner shell, or pile proper, was inserted and driven until it sheared the rivets r and was forced through the outer shell as shown to the required depth. The annular space between the inner and outer shells and also the pile proper were filled with concrete and an envelop of the same material was formed around the pier cap and the leg of the rocker bent supported by the cap, as shown by Fig. 7.

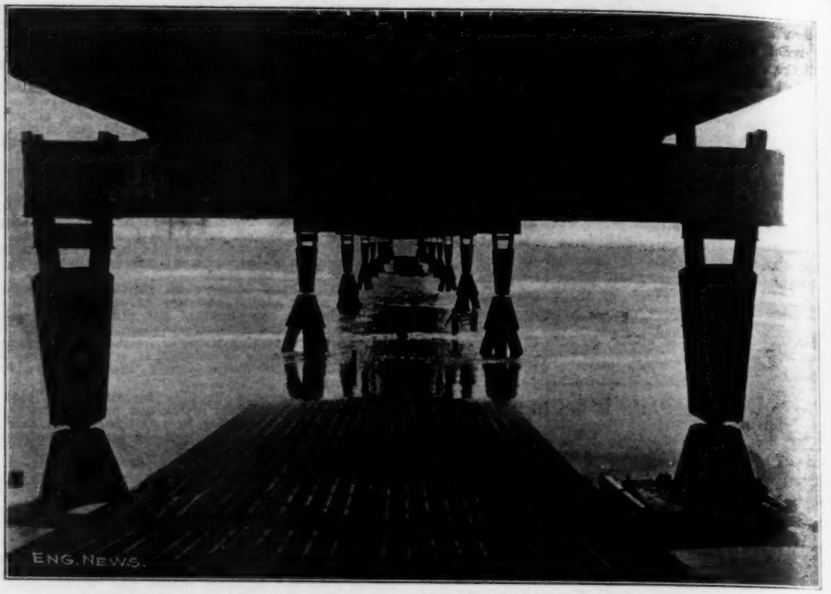


FIG. 7. VIEW SHOWING CONCRETE ARMORING OF PIER CAPS AND ROCKER BENT POSTS.

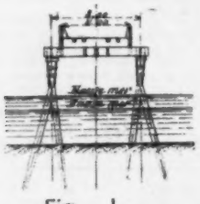


Fig. 1.

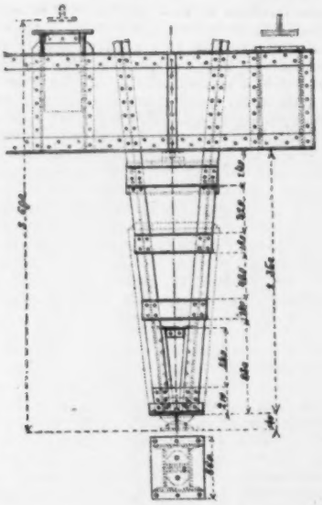


Fig. 3.

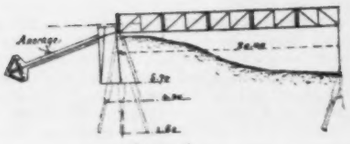


Fig. 4.

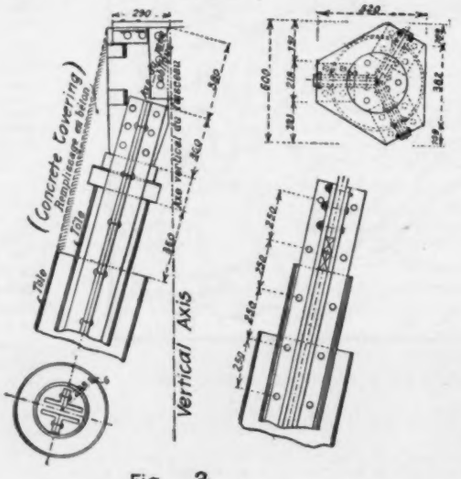


Fig. 2.

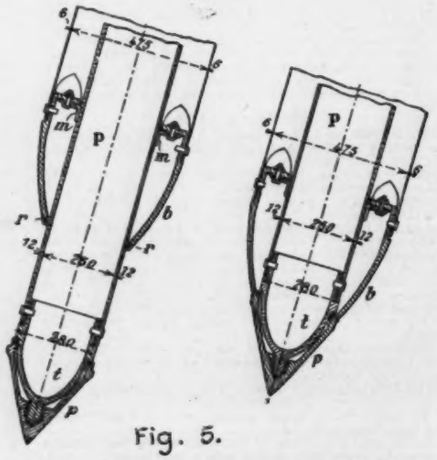


Fig. 5.

FIGS. 1 TO 5. STRUCTURAL DETAILS OF STEEL LANDING PIER AT LOME, AFRICA.

The pier was designed and built by the Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg, and we are indebted to an article in "Le Genie Civil" of July 15, 1905, for the information from which this description has been prepared.

THE CHEMICAL PROFESSION AND ITS OPPORTUNITIES.

By Wm. M. Booth.*

Every bright young man who has to depend upon his own resources is now advised to get an education. Our colleges and universities are filled with earnest men clamoring for knowledge which can be turned to practical account in providing for themselves and for the families which, within ten years from college entrance, are usually their charges. Many young men in search of a livelihood are now inquiring what future chemistry offers.

There are two distinct fields for the young chemist: teaching and commercial practice. To be a successful teacher a man must enjoy the companionship of young people, and must take actual interest in their studies and sports. His income will be from $700 to $1,200 per year, with perhaps an increase of $100 per year annually for about ten years. With close economy he can marry and lay the foundation for a home. His tenure of office is always insecure and his mode of life and thought are such as to make him very dependent upon others. The social advantages of the position and the opportunities for forming valuable friendships are not to be overlooked; but, on the other hand, a change of administration or an unfortunate turn of events may set him adrift with scarcely a month's notice. The science instructor in secondary education must be, first of all, a disciplinarian; then a teacher, and his lot is cast among boys and girls of from 16 to 20 years of age, when character-making is about as an important a feature as science teaching. Ten years of one kind of work unfits a man for any other. This is particularly true of teachers!

Department teachers, as a rule, dislike to accept purely executive positions, although the salary may be double that given the head of the department. High school chemical positions in our largest cities pay as high as $3,000, and are eagerly sought. Any young chemical graduate will usually find from 50 to 100 applicants for every position paying above $700. Teaching positions are largely obtained through agencies, which require 5% of the first year's salary after the contract is signed.

*Chemical Engineer, Dillaye Building, Syracuse, N. Y.

FIG. 6. VIEW OF TOP OF TRIPLE PILE PIER AND CAP.

A science teacher's position in a high school, however, should be only a stepping stone for any bright man; and after several years' service he should have made a reputation in the community in the way of analyses, recommendations regarding commercial processes, etc. Young chemists may in this way become interested in waterworks, gas works or local manufacturing corporations requiring chemical knowledge. An ambitious young man holding a high school chemical position can also study for and obtain an advanced degree which will allow him to enter a broader field; a college, a technical school, or he may thus become an executive. A large number of young men who graduate in chemistry are now required annually as instructors in large colleges and technical schools. Such men are at the outset paid from $300 to $600 per year, and are given the privileges of the university while taking work toward advanced degrees. With tutoring, such positions are often worth $1,000 per year.

For a young man who wishes to make himself felt in the chemical world, I believe, there is no better field upon graduation than as an instructor in a modern engineering school. The instructors and professors in engineering schools are constantly called upon to advise manufacturers. The government appoints them in connection with important investigations, and they have given us some of our most valuable information regarding mechanical and chemical processes. If a young man intends to become a teacher of chemistry and perhaps a captain of industry, with superior advantages for study, investigation and business advancement, the technical school offers, I believe, the broadest opportunity.

The Federal government is now employing a large number of men in detecting the adulteration of foods and in carrying on investigations of an abstract nature. Others are making analyses for the Geological Survey, and adding valuable information in reference to our mineral resources. Four men will probably be required in the near future where now but one is employed. As a natural consequence of government supervision of foods and agricultural products, state testing stations have been found necessary, and are already doing efficient scientific work.

We often hear and read of the great impetus given to German industry through superior commercial and chemical knowledge. Thousands of skilled professional chemists control the industries of Germany. The business men of that country have learned that routine and research chemists are good business investments, and have often agreed to maintain a staff of technical men, constantly experimenting, with the hope that their discoveries may pay them a high percentage upon the investment.

Large concerns in the United States have found how advantageous it is to maintain testing departments, and are very rapidly adding laboratories. Competition demands economies that the commercial chemist only is able to suggest. The various possibilities in this direction offered a young man are to-day almost without limit. Upon graduation from college the young chemist may get into a metallurgical establishment. He usually knows little of the business and accepts menial routine work for months at from $1 a day to $10 per week. If he is earnest and capable, he is slowly advanced to responsible positions. If he has, in addition to these qualities, business capacity, the works may become his charge with as large a salary as the business affords.

Dr. E. R. Scribb, of Brooklyn, is largely responsible for the application of scientific methods to the manufacture of drugs and chemicals. He paid young college men $10 per week, who were at the outset often worth less than ordinary workmen. In addition, he maintained a staff of chemical experts at both of his plants, and has made it necessary for manufacturing chemists everywhere to maintain a uniformity of product which was unknown forty years ago.

Hundreds of young men with a chemical education are to be found in the far West among mines and smelters. A gold assay may be obtained for from 25 cts. to $3, and the business of assaying alone is not remunerative enough to attract resourceful young men, but those who are looking for possibilities often make money about mines, and themselves become owners and managers. These men sacrifice home and friends, and must be staunch physically and mentally to withstand the strains and temptations of life in such regions.

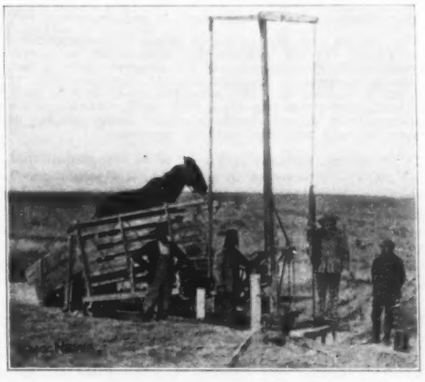
My belief is that professional men usually receive what they are worth. Many professional teachers would be unable to earn the meanest living in the commercial world, and many routine chemists have little business sense. If our technical institutions could turn out business chemists and business engineers there would be fewer failures among their graduates and greater demand for their services. Colleges and universities sending out analytical chemists ought to give them a practical training. If the public asks for aid in living and doing business, and the chemist offers a thesis with an unpronounceable name, he must expect defeat. Theoretical studies will naturally be under the direction of college or university professors or government employees with an assured living. Young men who have to depend upon their own resources should be furnished some other form of training.

ROCK DRILLING BY HORSE-POWER.

The accompanying view shows a novel drilling machine, made up from parts of different machines and from other material found on a Western ranch. It is in use at a rock cut on the outlet canal of the Julesburg Irrigation District, Sedgwick County, Colo.

The horse-power is belted to a pulley, thence through a gear wheel to a crank, which strikes a lever and operates a walking beam on top of a post, thus raising a drill, which falls by gravity.

A piece of railroad steel is fastened to the top of the drill to give additional weight and to increase the force of the blows. About 40 strokes per minute were made, drilling, with a 1¾-in. steel bit, three to four 10-ft. holes per shift.



A Horse-Power Rock Drill.

We are indebted to Mr. T. W. Jaycox, State Engineer, of Denver, Colo., for the photograph and notes here reproduced.

THE LARGEST SAILING VESSEL IN THE WORLD is the German bark R. C. Rickmers, which was launched in Germany in February. She is a five-master, 441 ft. in length, with a width of 54 ft. 3 ins. and a draft of 26 ft. 9 ins. Her displacement is, approximately, 11,350 tons, giving a gross burden of about 8,000 tons. She is a sailing vessel, but is fitted with triple-expansion 1,000-HP. engines, which under favorable circumstances, will enable her to make from 6 to 7 knots under steam, even when fully loaded.

THE WORLD'S INTERNATIONAL COMMERCE will aggregate fully 25 billions of dollars in the year 1906. In 1900 it aggregated, in round terms, 20 billions; in 1890, 17½ billions; in 1880, 14¼ billions; in 1870, 10½ billions; in 1860, 7¼ billions, and in 1850, 4 billions. By the term "world's international commerce" is meant the imports plus the exports of all countries of the world from which statistical trade reports were available at the dates named. The United States has now the largest amount of exports of any country of the world, but ranks below England and Germany in its imports.

ADDITIONAL EXAMPLES OF STREET SUBSIDENCE IN SAN FRANCISCO.

To supplement the notable record of damages to streets and water mains in San Francisco given by Prof. Derleth in our last issue, we present herewith two views of the San Francisco Post Office Building and a view on Valencia St., showing well the remarkable subterranean movement which the earthquake produced in the "made ground" portions of the city.

THE MAJORITY REPORT OF THE SENATE COMMITTEE ON THE TYPE OF THE PANAMA CANAL.

The Senate Committee on Interoceanic Canals, which has had in charge the Panama Canal investigations, took a vote on May 12 on the type of canal and stood 5 to 5, as reported in our last week's issue. On May 17 the return of Senator Carmack gave an additional vote for the sea-level plan, and it was therefore reported to the Senate by the majority of the committee. We give the portions of this report of most interest to our readers as follows:

On Feb. 19, 1906, the President presented to the Congress the report of the Board of Consulting Engineers and the report of the Isthmian Canal Commission upon the type of canal at Panama.

The majority of the engineering board recommended the adoption of the sea-level type of canal, while the minority of the board proposed that six lift locks be introduced in the canal. Three of the engineering members of the Isthmian Canal Commission indorsed the minority report and the other engineering member indorsed the majority view. It thus appears that of the engineers who have considered officially the question submitted nine favored the sea-level type and eight the lock type.

The Secretary of War also favored the lock type, and the President in transmitting the report and correspondence remarked:

After careful study of the papers submitted and a full and exhaustive consideration of the whole subject, I concur in the recommendation of the Secretary of War.

The President, in closing, further remarked:

The law on our statute books seems to contemplate a lock canal. In my judgment a lock canal, as herein recommended, is advisable. If the Congress directs that a sea-level canal be constructed, its direction will, of course, be carried out, otherwise the canal will be built on substantially the plan for a lock canal outlined in the accompanying papers, such changes being made, of course, as may be found actually necessary.

The President remarks in his letter of transmittal that "the existing law seems to contemplate a lock canal," and the majority of the Isthmian Canal Commission say that the lock plan recommended "is of the same type as that recommended by the Commission of 1899-1901 and adopted by Congress, at least by inference, in the act approved June 28, 1902," the changes now proposed "being such as Congress could not possibly have intended to prohibit when it adopted the old plan."

The Isthmian Canal Commission in its report dated Nov. 16, 1901, recommended a lock canal having certain physical characteristics, the most noted differences between this project and the one now proposed by the minority for adoption are several, and some of them important, as follows:

Project, 1901.		Project, 1906.	
Depth of prism, ft..	35	Depth of prism, ft..	40-45
Bottom width, ft...	150	Bottom width, ft...	*200
Number of locks...	5	Number of locks...	6
Summit level, ft...	90	Summit level, ft...	85
Length of locks, ft.	740	Length of locks, ft.	900
Width of locks, ft..	84	Width of locks, ft.	90
Dam sites, Bohio.		Dam sites, Gatun, La Boca, Panama, Ancon-Sosa.	
Total excavation (nearly), yds...	96,000,000	Total excavation (nearly), yds...	95,000,000

*And over.

The estimated cost of the 1901 project, including sanitation and general contingencies, was $144,233,358, while the project of 1906 was estimated to result in an outlay of $139,705,200, which includes engineering and contingencies, but not sanitation. If an adequate allowance for general above special contingencies be made, and if sanitation be included, so as to bring the two estimates to a parity, it is evident that the cost of the lock canal now contemplated will largely exceed the cost estimated for a different work in 1901, and which estimate, it is said, Congress accepted as the cost of the canal.

That the cost of the work constructed, to conform to the requirements of the Spooner Act, would exceed the cost estimated by the Commission is evident on its face, for this act required that the canal be adequate in capacity to afford convenient passage for the largest ships engaged in commerce and those reasonably to be anticipated. The project of 1901 provided for no greater depth in the excavated channel than 35 ft. and for locks 740 ft. long and 84 ft. wide, while ships are now constructing, and will soon be in service, 788 ft. long, 88 ft. beam, and drawing 38 ft. The differences between the physical characteristics of the former and now proposed lock canals are so marked, and the probability that the total appropriation made and to be made under the Spooner Act would be insufficient to carry the 1906 lock proposition to completion, convinces your committee that the presumption is without sufficient basis of fact or probability to justify the prosecution of the work unless and until Congress shall grant the requisite authority to that end.

CONGRESSIONAL ACTION REQUIRED.

An undertaking of this vast magnitude and of such supreme importance to the commerce of the world, and especially to the military and commercial needs of the United States, should not go forward without an authoritative expression by the law-making power settling definitely the questions of use or non-use of locks and the dimensions of all the principal component parts of the most colossal work that mankind has ever undertaken and upon which questions the advice of the most competent and experienced engineers in the world was solicited and secured.

Including the Commission of 1899-1901, the Commission of 1904, the Consulting Board, and the present Commission, including also the two chief engineers who have had charge on the Isthmus, it is found that 28 distinguished men, 23 of them engineers, have since 1899 for considerable periods of time been engaged in studying the vast proposition of dividing the continents and joining the oceans. If there be included also the large number of French and other European engineers and others employed by the French companies, the array of professional men who have aided in the elucidation of the problems becomes still more notable.

It seems to your committee that all the important facts bearing upon the task that confronts us are now sufficiently well known and made patent to the minds of the laymen to not only justify Congress in deciding the technical questions presented by the President in his message of Feb. 19, 1906, but to require that the representatives of the people discharge the duty which rests upon them at this important juncture to end the discussion which has continued for so many years as to the type, dimensions, and capacity of the Panama Canal.

It is due to the executive branch of the Government that the uncertainties confronting the President as to his power in the premises be settled and disposed of affirmatively once and for all by the only authority competent to pass upon the question—the national legislature.

After very careful study of all the literature on the subject and extended hearings of many experts your committee has reached the conclusion that the following propositions are irrefutable:

1. The ideal canal at Panama is the one at sea level.
2. That its construction will be attended by no more, and probably with much less, hazard than the one requiring 170 ft. of lockage and enormous earth dams on doubtful foundations.
3. That a sea-level canal will be much safer and more convenient than the other.
4. That but a little longer time will be consumed in its construction than the one with unprecedented lift locks.
5. That the maintenance of the canal at sea level will be much simpler and far more economical in operation and maintenance.
6. That the realizability of the ideal type at Panama is one of the chief advantages of this route.

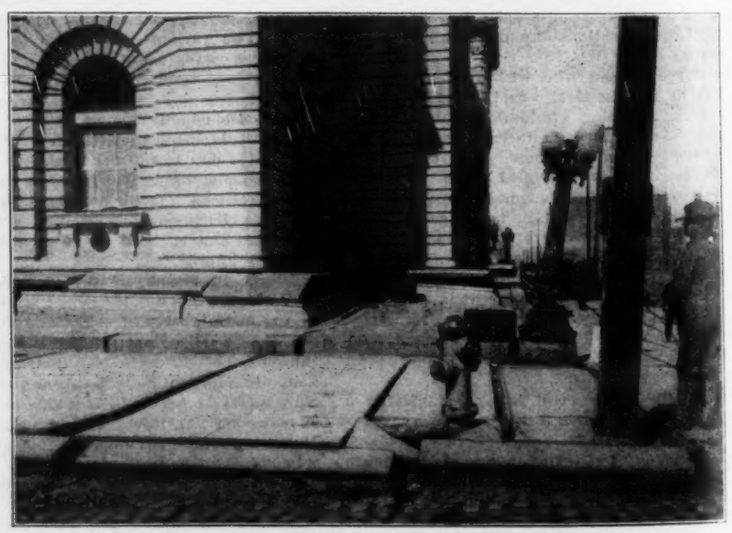
But several able engineers, all Americans, have dissented from some of these propositions. These gentlemen have, in our belief, given undue weight to the example of the only American work that facilitates the transit between two of the Great Lakes of vessels of considerable size, and they lay very great stress upon the proposition that through the utilization of locks at the Isthmus a result will be accomplished that the President does not even mention in his original instructions or in his address of Sept. 11, 1905, nor in his message to Congress—the estimated saving of cost of the work in money.

There was no possible method by means of which ships could be passed between Lakes Superior and Huron save with some lifting and lowering device, for these lakes are at different levels, and the lock was naturally resorted to; yet it is an obstruction, however regarded, and could not and cannot be avoided at the Soo, but similar devices at Panama are wholly unnecessary. To permit their introduction at this narrow isthmus, where the oceans are at one mean level and only 50 miles apart, will result in obstructive delays and unnecessary risks, which ought to be avoided and can readily be avoided. The tides of the two oceans now approach so that a distance of but 24 miles separates them, and the highest part between is only about 160 ft. above sea level. It seems to us that this obstacle should be wholly removed, and not left in part even to be scaled or climbed over.

LOCKS AND DAMS.

We are asked to accept the conclusions of the minority of the Consulting Board, that more than 2½ miles of ponderous locks with their connecting jetties shall be introduced—locks with dimensions far exceeding any

Northeast Corner of Post-Office Building.



SOUTHWEST CORNER POST-OFFICE BUILDING, SAN FRANCISCO. PAVEMENT AND CURBING DISPLACED BY EARTHQUAKE.

STREET SUBSIDENCE IN SAN FRANCISCO. VIEW ON VALENCIA ST., NEAR 18TH ST., OPPOSITE SITE OF VALENCIA HOTEL.

(It was at this place that street water mains were broken. The street dropped about 4 ft. and moved eastward about 6 ft. at the maximum point. The 24-in. main on the left was laid after the fire. All buildings in this vicinity were burned.

that have ever been made and yet of a size that will probably, indeed almost certainly, soon be found to be inadequate for the modern steamship.

There would be three locks in one flight, with no stretch of canal between, and two in another flight, an arrangement that is condemned as very objectionable and unsafe by the majority for use by the modern vessel of ten, twenty, or more thousand tons. The entry through and exit from these contiguous locks is attended with very great danger to the lock gates and to the ships as well, as has been clearly pointed out in the evidence before us.

No mechanical device has ever been made that is not liable to derangement and accident. The common cause of such accidents to locks and ships results from wrong signals from the masters on the bridge to the engineers, or from a misunderstanding or misreading by the engineers of these signals. The mistake results in the movement of the ship in the wrong direction, and of her going ahead when it was intended she should back, or vice versa. As a consequence, lock gates have been wrecked and the locks put out of use. Double gates have been used and are proposed by the minority so as to minimize this danger, which is a clear acknowledgment by the minority of the hazard.

If a ship proposing to pass a lock to a lower level should wreck the lower gate of an upper lock, or of a single lock, the ship and all lock gates below in the series, as well as the canal beyond, would be ruined. If the upper of the Gatun locks or the Pedro Miguel lock should be thus opened to the free exit of water, the Gatun Lake would be more than one-half emptied. While the water was escaping—a period probably of several weeks—no new gates could be set to replace those destroyed. The wreckage that would result from the plunging down through the series of a great ocean steamer and the havoc wrought to the canal below would require years to repair.

It is not a sufficient answer to this forecast to say that an accident of such magnitude has never happened. Since human minds, hands, eyes, and ears are fallible it is only a question of the happening somewhere and somehow of the unexpected. The jeopardy to which these vast locks and their mechanism are liable from convulsions of nature will be referred to later.

Earth dams founded on the drift and silt of ages, through which water habitually percolates, to be increased by the pressure of the 85-ft. lock when made, has been referred to by many of our technical advisers as another element of danger. The vast masses of earth piled on this alluvial base to the height of 135 ft. will certainly settle, and as the drift material of this base or foundation has varying depth to 250 ft. or more, the settlement of the new mass as well as its base will be unequal, and it is predicted that cracks and fissures in the dam will be formed which will be reached and used by the water under the pressure above mentioned, and will cause the destruction of the dam and the draining off of the great lake upon which the integrity of the entire canal rests.

Your committee cannot see that any necessity exists to incur these hazards, for with a small prolongation of the time for construction and a relatively inconsiderable increase of cost the greatest vessels that are used in commerce can always remain in salt water and proceed without hazard of any kind at 5 or 6 miles an hour, as they do at Suez.

The statement of the Board of Consulting Engineers has not been refuted or even controverted that with the Panama tide gate wide open the canal would be usable by vessels of all sizes for approximately one-half the time. If the commercial and naval movements should become great, the sea-level canal can be widened to 300 or even 500 ft. and the "Straits of Panama" become a reality.

TIME.

The sea-level project contemplates the removal of about 110,000,000 cu. yds. in the 8 or 9 miles of what has been called the Culebra Divide. The lock plan contemplates the removal of over 53,000,000 of these yards, or nearly one-half of the whole, including all that portion most liable to slide, and so would leave nearly 57,000,000 yds. in place. To omit to take this out is to confess our impotence, which is not characteristic of the American people, their engineers or contractors.

In the last year of the making of Suez 2,000,000 cu. meters of earth and rock were taken out, a considerable part of it by hand labor. This was officially reported by the French engineers, and in the doing of this, methods, appliances, and machines were used that were obsolete, condemned, and discarded a generation ago. In the making of the Manchester Canal in England 13,000,000 yds. of rock and stiff clay were excavated in a year, and could have been greatly exceeded with a larger plant. From the Chicago drainage canal, 12,500,000 yds., much of it rock. These examples show that without a plant of increased efficiency over those used before, the 57,000,000 yds. left undisturbed at Culebra by the minority could be extracted in two or three years, for it occupies a stretch of some 8 or 9 miles, affording space for a great many points of attack.

RISK IN CONSTRUCTION.

Some stress has been laid—unduly we think—upon the hazard that would attend the making of the canal at one level. It is very difficult to understand the basis for this claim. The proposition is one almost entirely of simple excavation requiring the minimum of skilled labor. The works requiring artisans in any considerable number (besides those operating the excavators and railway trains, which will be much alike for both types) are but two in number, the Gamboa dam and the tide gate, the two requiring about 1,250,000 cu. yds. of concrete masonry; whereas the six locks in the high-level plan will require quite three times as much masonry, besides a very large quantity of metal work.

The danger feared from an inundation of the excavated work in the upper portion of the lower Chagres has been referred to as considerable. If these workings should be flooded out the damage would be inconsiderable for the freshets only last two or three days at a time. The Gamboa dam would be ready to control the Chagres floods before the Culebra excavation could be half finished, and then the excavation in the prism to and below sea level in all portions of the line would go on without interruption or hindrance from the waters of that stream.

That a masonry dam with its base on rock at sea level, its crest raising the waters of the river 170 ft. above the sea, will effectually control the Chagres is as certain as that many much larger streams in other parts of the world have been controlled by similar means under conditions far more unfavorable than those to be encountered at the Isthmus.

SAFETY IN OPERATION.

When the Chagres is subdued and controlled and the sea-level canal made its use will be attended with no more risk than an equal sailing distance in the oceans. The underwriters charge no higher rates to vessels navigating Suez, Manchester, Kiel, Corinth and the Soo than they do to vessels engaged in ocean commerce. The same will be the case at Panama if the ideal plan is followed. The small vessels seeking transit, which will be nine-tenths of all, will have nothing to impede them save to slow down when meeting other ships of moderate size, or to moor when meeting very large vessels. The delays at Suez, due to these tie-ups, amount to only an hour and a half per ship.

A vessel has never entered the port of New York that would not move in the 40-ft. Panama sea-level canal with 7 ft. of water under her keel. At certain times of tide the gate at the Pacific end would probably have to be used, involving in such contingency a delay of three-quarters of an hour, but this is the only obstruction, and it is proper to add that some distinguished engineers are of the opinion that such a device will not be found to be necessary at any time. The board of engineers, in an abundance of caution, have provided in the plans and estimates for such a gate or lock.

The average time of transit of vessls, large as well as small, through the Suez Canal is only 17½ hours, including delays caused by mooring at meeting points. Its length is more than twice that of the Panama Canal. Hundreds of vessels of from 10,000 to 14,000 tons burden have already passed through Suez, whose bottom width is only 108 ft. and depth only 31 ft., while at Panama the minimum bottom width is 150 ft. and depth 40 ft. throughout.

Yet these very large vessels habitually pass through the 104 statute miles at Suez in about 17½ hours.

TIME OF TRANSIT.

It is admitted by the minority of the board of engineers that all except the larger vessels, exceeding the length of 540 ft., will be able to pass the canal of one level in less than nine hours, at the rate of 10 ships a day, or in 9.6 hours at the rate of 15 ships daily, while the majority claim, and cite Suez as an example, that the largest ships now in service will be readily passed in eight hours.

The minority urge that the estimates do not provide for the cost of constructing mooring places such as are found at Suez, but the majority reply that every mile of the Panama sea-level canal will be a passing place, if only a few piles are driven or posts erected at the banks for attaching lines, as it is well known that the width of Suez Canal at these mooring places, only 20 in all, is less than the proposed minimum width at Panama.

The average time lost by vessels in passing the largest of the Soo locks in the year 1905, was 35 minutes, while the time required in passing the canal itself, only 1.6 miles long, including the locks, was 1 hour and 39 minutes. This lock is smaller in plan area than the proposed Panama locks of the minority and of about two-thirds the average lift. It requires less time to fill and empty than will those proposed by the minority for Panama. It is conservative to estimate that the time that would be required to pass these six locks would be four to five hours, or one-half as long or more to pass the locks alone as it would require to navigate a sea-level canal from ocean to ocean.

MAINTENANCE.

This will be an important item in any canal at Panama for the maintenance of the navigable channels and harbors, for each plan would require considerable dredging. The maintenance of lock and sluice structures and repairs will not be light. The transit service, including lighting, tugs, buoys, etc., buildings and shelter for employees and property, general expenses, and sanitation, must be included.

The Consulting Board did not submit any estimate of cost of maintenance, repairs, etc., but the minority submitted two computations for each type, based upon certain estimations and precedent. The mean of the two for the respective types is about the same.

Members of the Consulting Board who appeared before the committee submitted compasative estimates in detail, claiming that the sea-level maintenance cost would be at least $800,000 less than the other, and one member gave reasons why he thought that the cost of maintenance and operation of the lock plan would be much greater than stated above.

Your committee adopts the view that a close estimate of the cost of operation, repairs and general maintenance demonstrates that such charge for the sea-level canal will be at least $800,000 annually less than for the type of canal proposed by the minority.

EARTHQUAKES.

The recent calamity that overwhelmed one of our great cities has caused many forebodings. The assertion that any particular spot in the tropics is exempt from all danger from such convulsions of nature as recently visited California, or wrought great havoc near Charleston, S. C., in 1886, or changed the face of nature in southeastern Missouri near the beginning of this century, would not be hazarded by any wise man. That the Isthmus of Panama is not exempt conclusively appears in Senate Document No. 264, Fifty-ninth Congress, and we can have no guaranty that the Canal Zone will in the future be free from such disaster.

The canal structures that would be most exposed to injury by the passing of earth waves or violent movement of the earth's surface are the locks proposed by the minority, whose walls, many hundreds of feet, or even two or three thousand ft., as at Gatun, would, at least some of them, be more than 75 ft. high and entirely unsupported on one side save for a part of the height by water. If these walls should be moved at all, the natural and probable result would be their leaning, and so prevent the closing of the gates—an injury for which a suggestion of extra gates on hand would be useless, for no one could guess the extent of the movement. But the most likely effect of such shock would be the fracture of these lock walls, in the repairing of which much time—months or years—might be required, and thus cause interruption of traffic or the abandonment of the canal.

The minority suggest that the dam at Gamboa included in the plan of the board would be as likely to sustain injury from such convulsion as the structure above mentioned. This is not the fact. The Gamboa dam, as projected, is to be built on a solid rock foundation, reinforced with wide base and buttressed at either end by hills of rock. It is a structure the least likely to be affected of any superimposed on the earth's surface, and no record is found of any similar structure being permanently or temporarily injured by an earthquake. The side slopes of the Culebra cuts would be no more likely to be disturbed than are the nearly vertical hill slopes near the divide, that have never been affected.

An earth dam on an alluvial base, as proposed by the minority, might be fissured if earthquake waves passed the locality, and if a crack in the dam or its base should open, the dam would go out, the lake be drained, and the canal ruined.

At San Francisco, where the water pipes were broken, the disaster was greatly augmented from this cause, for the water could not be held in the pipes and directed on the flames. What would happen to the aqueduct, conduits, pipes and valves buried in the concrete walls used for filling and emptying the locks can not be well conjectured.

IMPORTANCE.

That the route of interoceanic transit will not for many years attain the commercial importance that Suez now enjoys is evident. The Old World populations, served directly by the latter route, are many times greater in numbers and requirements than are the present New World populations. The most careful study of commercial statistics by conservative and competent statisticians has resulted in an estimate that the trade of the world likely to seek the Panama Canal, assumed to be ready for use in 1914, would be about 7,000,003 tons (see Professor Johnson's statement printed in the report of the Isthmian Canal Commission of 1901), and, in our judgment, is entitled to great weight. It is accepted by the committee as the safest and most reliable of any of the guesses upon this subject.

The Suez Canal is now so profitable that notwithstanding the constant decrease in tolls the profits are constantly augmenting, and now exceed 25% yearly on the capital invested. But such financial results are not to be expected for Panama at first with any probable conditions of trade and rates of tonnage charged.

But the canal has a value to the United States that cannot be measured by units of value or percentages of profit. The object lesson which the passage of the Oregon from the Pacific to the Atlantic at a time of great anxiety settled the question of the construction of a waterway connecting the waters of the Atlantic and Pacific oceans. None of the great powers of the world are so situated geographically as to be advantaged to any such extent as the United States will be by being able to quickly transfer its fleets of warships from one of its own coasts to the other, or from one ocean to the other for the purpose of defense or offense.

The Panama Canal nearly doubles the efficiency of our navy, and will vastly contribute to our security. If free from all obstacles to quick transit, a fleet of 100 warships of the average size, all moving in one direction, and the route clear, could be passed from ocean to ocean in less than a day.

In a report of this committee it is not necessary to dwell upon the fact that all naval commanders and commercial masters of the great national and private vessels of the world are almost to a man opposed unalterably to the introduction of any lock to lift vessels over the low summit that nature has left for us to remove.

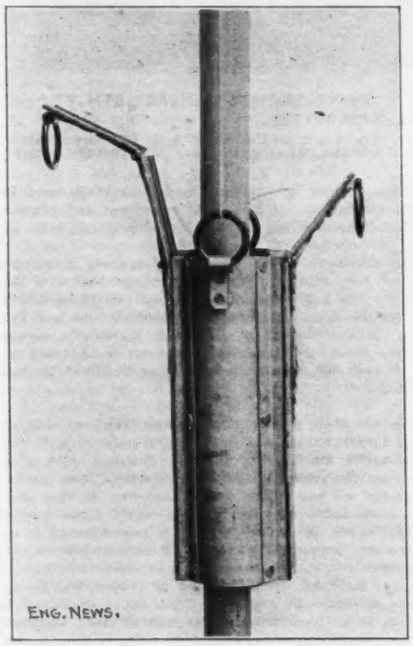
THE ULTIMATE COST.

As before stated, the Spooner Act appropriated a sum that, applied to the work to be taken in hand possessing the physical characteristics and dimensions satisfying the requirements of the statute, was entirely inadequate and, considering the large expenditures already made in preparations, would certainly be found insufficient to construct the minority lock plan. There are two estimates now before the Senate, both originating with the Board of Consulting Engineers. The basis of computation of cost at certain unit prices was adopted unanimously by the board, and we are told that the cost with the 20% allowance for contingencies, will be for the sea-level canal the sum of $247,021,200. Your committee has adopted the figures stated by the majority on page 64 of its report of a total of $250,000,000 for the ultimate final cost of the sea-level canal.

The minority tell us that their multi-lock canal, which your committee considers to be only a provisional plan, will cost $139,705,200.

If the increased annual cost of operating the multi-lock canal, which your committee estimates at $800,000, be capitalized at 2 per cent, the Government rate of interest, the minority estimate is at once increased by $40,000,000.

The minority propose to submerge and destroy 75,500 acres of land. The lands to be thus appropriated and



A Form for Armoring Timber Piles with Concrete.

the lake formed by the dam at Gatun and those near the city of Panama are held in three general classes of ownership by—

1. The United States,
   (a) As vendee of the French Canal Company.
   (b) As grantee of the Government of Panama.
   (c) As owner of the stock of the Panama Railway Company.
2. The Government of Panama as applies to the public lands outside the Zone.
3. Private individuals.

While the United States is the owner of considerable land within the Zone, yet there is scarcely a parcel of the one hundred or more scheduled in the abstract of deeds respecting which a controversy does not exist in the matter of title or boundaries. Four parcels of land near Panama have been purchased by the Government since the canal property came under the control of the United States, and while the usual legal provisions were observed as to appraisement by disinterested arbitrators, yet in every case the payments made for these tracts were two, three, and even five times as much as the land could have been sold for to private buyers.

It seems certain, considering the clouded titles, the disputed boundaries, and the certainty that very high prices will have to be paid for land secured through condemnation proceedings, that the cost of the land yet to be secured for the multi-lock lake plan will reach a very large sum—almost certain to exceed $10,000,000. This item should be taken into account in considering the total estimate of cost of the completed work. If proper allowance be made for these increases in the cost of the completed lock canal, it seems to your committee certain that the total will reach at least $190,000,000.

The minority hope that ultimately the ideal [illegible] will be constructed, which is conceded to be the [illegible] sea level.

If the lock canal be made and ultimately [illegible]ened it would cost more than $200,000,000 to [illegible] it and probably result in serious interference [illegible] traffic. The dams, lock structures and machinery for [illegible]tion, costing at least $63,000,000, would in that event [illegible] absolutely useless and would require an expenditure [illegible]many millions to remove on account of obstruction [illegible] sea-level waterway.

As before stated, your committee feel entirely [illegible]dent that the Board of Consulting Engineers [illegible]d to study this problem have submitted a plan that [illegible]sounds in every respect to the conditions stated above [illegible] that the sea-level canal can be realized in ten or [illegible] years at a cost of not to exceed $60,000,000 above the [illegible]quired for the construction of the multi-lock canal [illegible]d by the minority.

We do not consider that this amount, large [illegible] itself, but small considering the questions involved, [illegible]ould for a moment be considered as a sufficient reason for rejecting the sea-level canal. There can be no canal of any type open to our navy and commerce for eight or ten years. By extending this time for even a longer period than your committee suggests, a sea-level canal can be realized, and we will have an American canal worthy in every way of our country.

A FORM FOR APPLYING CONCRETE ARMORING TO TIMBER PILES.

The accompanying engraving illustrates a metal form designed by Mr. Omar A. Stempel, of Clearwater, Fla., for applying concrete armoring to timber piles. As will be seen the mold consists of two semi-cylindrical forms whose longitudinal edges are covered with compressible material and are held together by a sliding clamp. Galvanized iron is used for the form.

In operation, one section of the form is placed around the portion of the pile above water and the compressible filling and clamp are placed; then second and third and other sections are similarly placed until the form extends to the bottom of the water. The form is finally pumped out and filled with concrete and then left in place until the concrete sets. To remove the form the chain of clamps is drawn off by pulling on the eye-rings; this leaves the two halves of each section of form free to separate and to be pulled away from the concrete and hoisted to the surface by the attached ropes. One of the advantages of this form is that it can be used for armoring either piles with free tops or capped piles in existing structures.

The form described is controlled by The Stempel Pile Protecting Co., Inc., W. F. Hughey, Secretary and Treasurer, Clearwater, Fla.

VANADIUM STEEL ALLOYS, according to Mr. J. Kent Smith in a paper read before the Liverpool section of the Society of Chemical Industry, are now being produced at the rate of 800 tons per annum at the Queensferry works of Willans & Robinson. The vanadium steel industry is altogether an English industry, 80% of the production being used for the construction of motor cars and omnibuses. The chrome-vanadium steels containing 10 to 20% vanadium show the most remarkable properties, the highest test yet obtained, after special heat treatment, being a maximum breaking strain of 103 tons per sq. in. This steel showed at the same time great resistance to dynamic and torsional tests, a combination of properties never before obtained, this being the peculiar feature of chrome-vanadium steels. The nickle-vanadium steels were of great strength, but showed lower resistance to dynamic and torsional tests.

A 1,000-VOLT DIRECT-CURRENT RAILWAY is being built between Cologne and Bonn, Germany, 17.6 miles. The terminal portions of the line are on the 500-volt city systems, but outside of these the working conductor consists of two overhead trolley-wires, hung from a suspension cable, which receive current at 990 volts dynamo pressure. Another peculiarity of the overhead work, besides the use of two trolley-wires in parallel, is the double insulation employed; the trolley-wires are insulated from the suspension cable and the latter is insulated from the pole brackets. The track rails are bonded by two flat copper strips at each point. The rolling stock is to be run in multiple-unit trains, up to four cars long (two motor-cars and two trailers). The motors, of which each motor-car has two, contain auxiliary or commutating poles between the (four) main poles. They are of 130 HP. each, at 700 r. p. m. The gearing is 1 to 3.1. The cars have both pneumatic and hand brakes. Current is collected by two bow collectors on each car.

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Entered at the New York Post-Office as Second-Class Matter.

We announced last week the grant by the Engineering News Publishing Co. and other publishers of technical books of a special discount on their publications for the benefit of those San Francisco engineers who suffered loss in the conflagration.

In our correspondence column this week, Mr. Otto von Geldern reports the formation of a committee to undertake the establishment of a new technical reference library for the use of San Francisco engineers. To aid in the prompt building up of such a library the Engineering News Publishing Co. will give such of its own publications to the amount of $250 as the committee may select. In our next issue we hope to be able to announce contributions for the same purpose from other publishers of technical books.

Such contributions by publishers, however, will of course include only books now in print, and there are very many engineering books out of print which ought to be included in every good reference library. We therefore bespeak the aid of the engineering profession at large in building up a library for the general benefit of their San Francisco brethren. Many engineers through change in their occupation or field of work have in their possession books which are of little or no use to them but which would be valuable additions to such a working library as it is desired to create in San Francisco. We suggest that any engineers able and willing to contribute in this way should forward to Mr. Von Geldern a list of the books which they can offer. In this way the committee can make a selection and the sending of duplicates will be avoided.

The Senate Committee on Interoceanic Canals, after splitting equally on the question of type, obtained, by the return of an absent member, a majority in favor of the sea-level plan. The substance of the report made by this majority is printed in this issue. It is needless to say that this vote and report settles nothing. It merely transfers the battle between the two types to the Senate itself; and if that body decides to endorse the sea-level plan, it will then remain to be seen what action, if any, the House will take. It is quite possible that with the hurry and confusion incident to the approaching close of the session the whole matter of Panama legislation may be left unacted upon, as was the case at the last session, in which event, doubtless, the Administration will proceed with the construction of the lock canal.

We shall not at this time take space to discuss the various arguments brought forward in the committee's report except to note that its remarks relative to earthquakes read rather strangely in view of the actual behavior of dams and other hydraulic structures in the San Francisco earthquake as reported in detail by Prof. Derleth in our last week's issue. There would be no more reason to apprehend the destruction of a great canal lock by an earthquake than of a concrete dam; for in fact the lock walls are great dams or retaining walls. The Panama locks should endure an earthquake with as little injury as the great 115-ft. concrete dam at Crystal Springs, which though located close to the fault line is absolutely uninjured by the earthquake. In fact the Panama locks would be even more stable against earthquake injury, for they would undoubtedly be heavily reinforced with imbedded steel, as all massive concrete built in the future is very certain to be. For a still closer parallel to the locks, we may take the dry docks at the Mare Island Navy Yard. So far as we have learned, these structures, although founded on piles (if we rightly recall) were uninjured by the earthquake.

The committee also thinks that an earth dam on an alluvial base (such as the Gatun dam) might be fissured, and "if a crack in the dam or its base should be opened, the dam would go out, the lake be drained and the canal ruined."

Against this conjecture we should like to set the statement in the minority report of the Consulting Engineers that an earth dam like that at Gatun is probably more nearly earthquake-proof than any structure possible for man to erect. A crack once formed in a masonry structure remains there, but a crack in earth at once closes up by the falling in and caving of its sides. Further, a crack in masonry or concrete is likely to follow a more or less direct line; but an earth dam for a country subject to earthquakes might well be built with a large amount of broken rock embedded through its mass as stone is imbedded in so-called cyclopean concrete. These stones would not only tend to prevent a crack forming but any crack which started would follow so devious and irregular a course that the passage of water through it would be greatly impeded and the choking of the fissure by material from its sides assured.

There has been no little speculation as to whether the mixed garbage, ashes and other refuse of an American city could be burned in one of the latest improved types of British refuse destructors and produce heat that could be utilized economically for raising steam for power purposes. The report of the test of the Meldrum refuse destructor at Wetsmount, P. Q., published elsewhere in this issue, shows both temperature and evaporative results that compare very favorably with the reports of similar tests abroad. As the tests are accompanied by preliminary estimates of capital and operating charges, and by reproductions of views and drawings of the plant, they will doubtless be studied with interest by engineers and city officials who are confronted with refuse disposal problems.

The Westmount destructor is to be operated in connection with a municipal electric light plant. It was estimated, in advance of construction, that the mixed refuse from a population of 10,000 or 12,000 would serve as the equivalent of 1,000 tons of coal a year, worth at least $4 a ton. It will be interesting to know how the actual results compare with this estimate, and also what offsets there will be against this revenue, due to the increased cost of feeding such low-value fuel to a furnace and the extra haul required for the ashes over what would be necessary if they were kept unmixed with garbage and dumped for filling or otherwise on the nearest available ground. All such questions aside, the whole North American continent owes thanks to Westmount for its pioneer step in testing in a practical way the heat-raising value of American mixed refuse. We have had some earlier boilers connected with garbage and refuse furnaces, but they did not make use of forced draft, regenerators and economizers, as do the most recent British furnaces, nor was any serious attempt ever made to utilize such steam as was raised by these boilers. We have also had a few installations of boilers to burn the rejected matter from municipal refuse-sorting plants, but these plants received dry refuse, chiefly, such as paper, rags, boxes, shavings and rejected household goods; with them, also, little attempt has been made to utilize the steam raised, except to operate endless sorting belts, paper presses and the like. Heat from one of the New York plants, it should be said, raises steam for the Williamsburgh Bridge electric lighting plant, while at Buffalo a refuse-sorting and burning plant has been combined with a sewage pumping station. The intention at Buffalo was to utilize the heat from the refuse furnace for driving the sewage pumps, but if we are correctly informed this has not yet been done.

The three books on garbage and refuse disposal reviewed in our Engineering Literature Supplement for May 17 exhibit a variety of opinion as to the utilization of heat from American refuse furnaces. As we have so often pointed out, the British destructors, like the one just installed at Westmount, burn mixed refuse, of which garbage forms a relatively small part. In American practice, heretofore, the attempt has been to burn garbage, mixed with more or less paper and the like, or else to burn only the tailings from sorting plants dealing with paper and other light, combustible rubbish. Ashes, in either case, are not passed through the furnaces. In the Westmount test, some 65% of the refuse fed to the destructor was ashes, cinders and unburned particles from anthracite coal, while 15% was paper and other light refuse, 5% miscellaneous wastes, and only 15% was classed as "garbage, manure and leaves." With this combination, aided by forced draft and a regenerator to preheat the air blast, the equivalent of 1.36 lbs of water, from and at 212° F., were evaporated for each pound of refuse, during an 8½-hr. test. To the believers in producing power from American refuse this result is certainly encouraging.

The railroad rate bill, which passed the House with only seven votes against it, passed the Senate last week with only three negative votes. During its stay in the Senate, radical amendments have been made, bringing express companies, sleeping car companies, and pipe lines for oil transportation under the jurisdiction of the Interstate Commerce law. The penalty of imprisonment has also been restored for those who give or accept secret rebates from established rates of fare and freight; private cars and private terminal tracks and sidings are brought under the law, and railways are prohibited from engaging in certain other lines of business, such as the production and sale of coal.

In short, the needed strengthening of the Interstate Commerce law which has been urged upon Congress year after year, is now practically accomplished, assuming, as now seems altogether probable, that the bill will become law without removal of these Senate amendments.

As for the rate-fixing feature of the bill, on which such a vast amount of discussion has taken place, there can be no denial of the fact that the power of the Commission to remedy evils in the rate situation is immensely increased. At the same time provision is made for a review of its acts by the United States Courts, which will set at rest all claims that the law is unconstitutional or that it will result in confiscation of railway property. That there has been any actual fear of the Government confiscating the property of railway stockholders by its rate-fixing policy is extremely doubtful, notwithstanding the declamations of the railway attorneys. The price of railway stocks has not been affected a particle by the final passage of the rate bill.

It is, of course, true that the bill falls short of what many would be glad to see enacted; particularly with respect to the still open question of what constitutes a "reasonable" rate and to the measure recently recommended by the recent national convention of State Railroad Commis-

sions of a Government appraisal of the value of railway property.

It rests with the railways themselves, we believe, as to whether and when further and more radical amendment of the Interstate Commerce law will be called for. If the railways accept in good faith the provisions of this law, and the decisions of the Commission under it, they will cut the ground from under the feet of those who are working for more stringent regulation.

If on the other hand the railways take advantage of the "Court Review" clause of the rate bill, as they may, to fight in the courts every order of the Commission relative to rates, and so nullify the intent of the law, there will certainly result an overwhelming sentiment in favor of rate legislation and rate control by the Government far more radical than that which is now in sight.

SUGGESTED PLANS FOR REINFORCED CONCRETE EARTHQUAKE-RESISTING FIREPROOF BUILDING CONSTRUCTION.

Reinforced concrete made an enviable record in the recent California earthquake disaster. No one, we believe, will dispute this statement who reads with an open mind the accounts of the behavior of this material published in this and preceding issues of Engineering News. It is true, of course, that there was not a large amount of reinforced concrete construction within the area of greatest damage and that the buildings in which it existed were not large or lofty, but this does not remove the fact that every reinforced concrete building in the district visited by the earthquake and fire is still standing with only minor damages to be repaired. Reinforced concrete stood up under the shock and the heat as did no other material with the possible exception of fireproofed steelwork. So much for the recorded facts; what lessons to the advantage of future permanency of building construction in earthquake countries may we reasonably draw from them?

The answer to this question has already been made by the enthusiasts in reinforced concrete work. It is this: The effects of both earthquake and fire point unmistakably to reinforced concrete construction as the very best. We have in our correspondence and interviews with engineers certain evidence that there are many who agree entirely with this radical opinion; we have also evidence that there are quite as many who hold contrary views. Between the two extremes of opinion we shall probably find the great majority of engineers and builders with simply an awakened belief in the real merits of reinforced concrete and in its possibilities when used alone or in combination with steel framing as a shock and heat resisting building material. It is along this middle line of thought that we ask attention for a brief period.

Two solutions of the problem of earthquake resisting constructions in both of which reinforced concrete is made an important factor have been advanced. It is understood, of course, that reference is had to fire resisting construction that is earthquake-proof. Timber construction properly designed will probably withstand earthquake shock as well as anything, but it is worthless in case of fire, and for various other reasons cannot enter certain fields of building work even in a region of cheap and available timber like the Pacific coast. We are speaking then of what may be defined as earthquake resisting, fireproof construction. For this, two general types using reinforced concrete have, as stated, been suggested. One is to build rigid monolithic structrues of heavily reinforced concrete, and one is to erect a flexible framework of steel and clothe it with a light mantle of concrete especially designed and reinforced to resist rupture, and if ruptured to cling still to its supporting frame.

The idea of a specially designed all reinforced concrete construction is presented in the letter by Mr. Hawkesworth, published in this issue, that of a concrete covered steel frame construction by Messrs. Weiskopf & Stern in our issue of May 17. Before taking up these communications individually, two fundamentals in which the writers of both agree may be mentioned. They are first that the ratio of height to lateral dimensions should be as close to unity as it is possible to make it, and second that the foundations should invariably be carried to solid materials—rock or hardpan. The wisdom and value of these two requirements are self-evident and they may be passed with no further discussion.

Starting with them as a basis Messrs. Weiskopf & Stern propose to build a steel framework with the connections of columns, beams and girders so designed as to allow the frame to adjust itself to unequal settlement of foundations within reasonable limits without permanent injury. To inclose this framework and for filling between floor beams reinforced concrete is proposed. We quote as follows:

> Floor construction should consist entirely of steel beams and girders, supported on steel columns, and the joist beams should not be spaced over 6 ft. apart. Floors should be of reinforced cinder concrete, the reinforcing consisting of tie rods spaced about 6 ins. apart and securely fastened to the beams, and a wire mesh should also be used in the floor slab, as an additional security to hold the concrete in position in case of fracture.
>
> The walls should be as thin as possible consistent with climatic conditions and the requirements of fire protection, and might better be made hollow with an air space. The best material for this purpose we believe to be reinforced concrete, with a framework of structural steel around all openings, and made practically in the same way as the floor construction described above, the important thing being that there should be plenty of steel reinforcement, and that it should be securely fastened to the steel framework of the building.

The construction suggested is logical and reasonable in conception and plan, and it derives additional importance from the fact of its actual use in the great work cited by its designers. The shocks and unequal settlement of foundations to which a ferry house is subjected are not dissimilar to the jar and movement of an earthquake shock; and a structure that will safely stand up to the one may reasonably be expected to show superior resistance to the other.

Turning now to the construction suggested by Mr. Hawkesworth, we find it based on an entirely different line of reasoning. In place of a construction designed to accommodate and adjust itself to abnormal movements we have a construction designed to resist such movements by its massive strength and rigidity. This is the true kernel of the author's idea; the method of extra-reinforcing the concrete is a mere matter of detail. No one will question the possibility of strengthening the ordinary reinforcement of concrete building members to provide for a reversal of stresses resulting from earthquake movements or any other cause; no one doubts the possibility of vastly increasing at reasonable cost the rigidity and strength of column, girder and beam connections. The question is, are rigidity and fixedness of position more desirable qualities in earthquake resisting construction than flexibility and adjustability? Probably no one can answer this question to the satisfaction of every one. Mr. Hawkesworth's letter barely suggests an answer. Here it may be noted merely that it is hardly fair to assume that a massive, rigid construction is distinctly inferior.

As already stated reinforced concrete buildings everywhere within the zone of the California earthquake shock withstood without exception the stresses brought upon them. Furthermore, the steel frame structures which in San Francisco suffered least injury were rigid, fixed jointed structures. If this record proves anything in respect to the question before us, it is that a flexible, hinge jointed construction is not a positive necessity to integrity of structure in case of earthquake shock.

In presenting the foregoing remarks we disclaim any attempt to settle the question of earthquake resisting fireproof construction. The evidence at hand, it seems to us, is too meager and uncertain to warrant such an endeavor. The purpose has been simply to direct attention to two suggestions that have been made toward a solution of the problem and to warn against a snap judgment in favor of any one type or style of construction as in all respects the best. May it not be possible for example that the character of the foundations and the shape of the building may have more influence on stability in earthquake shock than the fact that the superstructure framework is fixed or adjustable? Do we know whether the actual movement [illegible] deep rock and hardpan layers that would [illegible] reached by deep, well designed foundations [illegible] little or much movement? The fact that the [illegible] surface fill slipped and sloughed about under [illegible] shock is not certain evidence of this. Let us [illegible] evidence in some of these matters before we set our thumb on any one material or style of framing as the best.

LETTERS TO THE EDITOR

Aid for San Francisco Engineers.

Sir: Your letter of May 4 has been in my possession since May 12th, when I answered it by telegram.

I appreciate very fully the noble work of your noble paper, and in the name of many of the engineers of San Francisco, I thank you most sincerely for what you did.

The American Society of Civil Engineers has sent two cases containing office supplies, which arrived yesterday, and Mr. John C. Trautwine, Jr., has interested himself in our behalf in the most energetic manner, having shipped to us directly and indirectly all sorts of useful supplies that will be appreciated by those who are now in need of them. Money to the extent of $1[illegible] has been received, which it has been concluded to devote to the purchase of a new technical library so essential to engineers.

A committee has been appointed to take in hand the distribution of the material received, consisting of Edwin Duryea, Jr., chairman, Franklin Riffle, William Ham Hall, W. R. Eckart, Marsden Manson and Otto von Geldern, members of the American Society of Civil Engineers, and R. W. Myers and W. J. Cuthbertson, of the Technical Society.

It is a matter of great satisfaction to state that what has been sent thus far is ample to provide for the immediate needs of our engineers, and that they will purchase the more costly implements themselves as they get on their feet. It is the idea of the committee to make a charge for supplies to those who are able to pay, and to give them outright to those who are unable to pay for them. With the money so collected a fund will be set aside for the creation of a new technical library, the necessity for which will become more and more apparent as time goes on. And that leads me to the principal part of this subject, and that is, "the lack of engineering books." Not only has every engineer lost his individual library, but all the great libraries of the city were destroyed, so that we are in absolute need of an entire rehabilitation on this score.

I do not think that it will be necessary to raise any money for us by subscription to do this. As we obtain funds we shall purchase from time to time what may be immediately required. If the Engineering News will permit us for a time the privilege of obtaining engineering books at reduced rates, we shall take advantage of it and order the standard books usually found on the shelves of an engineer.

Our committee on donations has not met as yet, for the reason that the boxes and cases from the East did not arrive here until day before yesterday.

A number of committees, engineering and scientific, are at work studying the effects of the earthquake and the fire. You will, no doubt, obtain the results of some of these investigations in due time. There is a rich field for valuable studies in the line of engineering in this city at the present moment. Those who belong here and have their interests here look towards a speedy rehabilitation of the business of San Francisco, so that they may again be in a position to gain a livelihood for themselves and their families.

Very truly yours,
Otto von Geldern, M. Am. Soc. C. E.

1908 Broadway, San Francisco, May 16, 1906.

[As stated editorially in the "Literature Supplement" of our last issue, special discounts have already been granted by the Engineering News Publishing Co. and other publishers of technical books to the San Francisco engineers who suffered loss in the conflagration. Announcement with reference to contributions for the proposed reference library is made on our editorial page.—Ed.]

The First Three-Hinged Concrete Arch Bridge in America.

Sir: Your issue of May 10 contains an article describing a three-hinged concrete arch, for which the claim is made that it is "the first three-hinged concrete arch bridge ever constructed in this country." As a matter of chronological interest I feel obliged to differ with the author, Mr. H. F. Hackedorn, in that point, as an arch of this type was built in Mansfield, O., from plans

pre[illegible] by the City Engineer, Mr. Keith, in 1903-04. A des[illegible]on of this bridge with illustrations appeared in the "Engineering Record," Feb. 18, 1905.

Truly yours, Roy Antibus.

Mansfield, Ohio, May 14, 1906.

The Yellow Head Pass Across the Canadian Rockies.

Sir: When the Canadian Pacific Railway was constructed the chief engineer, Sanford Fleming, selected the Yellow Head Pass as the best route across the Rocky Mountains. As a matter of political expediency, the company rejected this route and chose instead the Kicking Horse Pass. It is noteworthy that this very pass which the C. P. R. refused to take, against the advice of its engineer, has now been chosen by its great rival, the Grand Trunk Pacific; and the vindication of the far-seeing judgment of Sir Sanford Fleming is well worth record.

J. A. M.

Ottawa, Ont., May 12, 1906.

Graft for Engineers.

Sir: The enclosed circulars and letter were received to-day, and I think they speak for themselves as a form of "graft." The last paragraph of the letter is the "joker."

Yours truly,

W. E. H., Chief Draftsman.

Milwaukee, Wis., May 17, 1906.

The circulars describe a steam jet blower for cleaning soot from boiler tubes and the letter (omitting names) reads substantially as follows:

Dear Sir: We are sure that you will be interested in the enclosed leaflet describing our steam flue blower which is now being adopted universally all over the country. Many consulting engineers are making it a point to include them in their specifications whenever they make any for return tubular boilers or boats.

We consider that you will render a great service to your clients by specifying the blower, but as a matter of courtesy, we shall be glad to allow you a commission of 10% on all the blowers that you may specify in contracts. Of course, we would expect that you would furnish us with the name and address of the party that is going to use the blowers so that we may put it on record.

Thanking you, we remain, Yours truly,

—— Company.

[For the benefit of any of our readers who may possibly be disposed to defend such methods of getting business—and getting money—we may mention that there is in the State of New York a statute which makes it a misdemeanor for an agent to accept a percentage or other perquisite on account of business done for a principal, and the one who bribes or attempts to bribe an agent by such an offer is also liable to punishment.—Ed.]

The Effect of the California Earthquake on Reinforced Concrete Buildings at Stanford University.

Sir: In Engineering News of April 26, on p. 478, the following words occur:

> The extensive buildings of the Stanford University, several of them of reinforced concrete construction and most of them low buildings, were partly wrecked.

These are not the facts of the case at all. There were only two reinforced concrete buildings at the Stanford University and these were both buildings of some height; the Museum, a building 312 ft. frontage and about 80 ft. high and Roble Hall, the girls' dormitory, a building containing over 100 rooms, and three stories high. Both these buildings are intact to-day. A loose chimney top broke a hole in the wooden roof of Roble Hall, but the damage was trifling. The Museum stands to-day perfect, but the brick wings which had been built on afterwards fell down. These buildings were built by Mr. E. L. Ransome, 15 years ago, and I was his superintendent of construction. All the brick buildings veneered with sandstone are badly injured, but I wish to point out that the reinforced concrete buildings, without a single exception, stood the strain. Our reinforced concrete business has enough to contend with without such a paper as the Engineering News taking the field against us.

Richard Keatinge.

Builders' Exchange, San Francisco, Cal., May 10, 1906.

[In answer to our correspondent it may be noted that the early account of the earthquake and fire to which exception is taken was of necessity compiled from the newspaper reports of the disaster. The later authentic accounts, furnished by our various engineer correspondents, have corrected the error mentioned, and have given much additional evidence of the good record of reinforced concrete.—Ed.]

The Strength of Riveted Tension Members.

Sir: The writer feels that thanks are due for Mr. Godfrey's paper "Some Tests Bearing on the Design of Tension Members" (Engineering News, May 3).

The fact that bridge material rarely has so small a ratio of net area to gross or so little material between edge of piece and hole seems to justify more confidence than is indicated by the sentence: "It is doubtful if the actual factor of safety . . . is as much as two." Will not some one publish tests of angles riveted to gussets according to best practice? The writer has long feared that the distance of gage lines from center of gravity of angles made many riveted structures much weaker than calculated. The deficiency of about 14% in case of first 9 and of about 23% in case of second 9 as compared with the third 9 tests recorded by Mr. Godfrey emphasizes that fear.

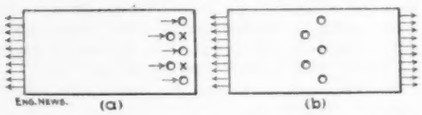
Yours truly, John Bartholomew.

Harrisburg, Pa., May 10, 1906.

Sir: I notice in your issue of May 10 that Mr. Theodore Cooper refers to my paper on the strength of riveted tension members as an "attempt" to prove that it is unfair and irrational to demand 30% more net area in a riveted tension member in a zigzag line than in a transverse line. He refers me to tests on riveted joints in substantiation of his insinuation and of the clause referred to in specifications.

The clause in specifications quoted by me does not mention riveted joints, but states specifically a riveted tension member. The tests made by me were not on riveted joint but on a plate representing one of the composite plates of a riveted tension member.

In the accompanying sketch a represents the condition in a riveted joint. The stress in the region of the rivets is not uniformly distributed across the piece, but is concentrated at the rivets. At points x there cannot be much intensity of stress, and the natural inference would be that rupture would occur by tearing between the points of concentrated load; that is, in the zigzag line between the rivets; unless the area straight across were less than on the zigzag line. The case of a plate in a riveted tension member is represented at b. Here the stress is uniformly distributed across the plate in the neighborhood of the rivets.



It was to prove the inaptness of conclusions from tests on riveted joints to a perforated plate in tension that my "attempt" was made. An analogy is seen in the requirements that the area beside a pin hole at the end of a tension member be from 25 to 50% greater than in the body of the member. It is because of the tearing tendency due to the concentration of stress at the pin that this requirement is quite rational. In a case where an auxiliary pin occurs at the middle of the length of a tension member, it would be just as irrational to demand an increase of 25% in the net section as it is in the case of a zigzag line of rivets in the body of a member.

Yours very truly, Edward Godfrey.

Monongahela Bank Building, Pittsburg, Pa., May 11, 1906.

Designing Reinforced Concrete to Resist Earthquake Shocks.

Sir: Among the many articles that have been published since the San Francisco disaster, advocating the use of reinforced concrete in rebuilding the city, the writer does not recall any mention of one point that is strongly in favor of this form of construction. Much mention has been mame of the fire-resisting qualities of reinforced concrete, and of its ability to resist earthquake shock on account of its massive nature, and steel reinforcement. We know that the steel skeleton of some of the higher buildings has been left fairly intact, while the shell of stone or brick which formed the walls was shaken off. From this it has been argued, and with some justice, that if the steel were imbedded in a homogeneous material such as concrete, having no planes of weakness due to mortar joints, the entire structure would withstand the shock, the low coefficient of elasticity of reinforced concrete providing for the excessive deformations produced. In fact, this argument has been fairly well demonstrated as correct, by the concrete construction already existing, not only in San Francisco, but in other localities subjected to earthquake.

The writer's suggestion, however, is to go a step further, and actually introduce into the design of reinforced concrete structures a reinforcement against the stresses produced by earthquake shock. At first sight this idea may be received with amusement, since, of course, we can never determine quantitatively beforehand the extent of these stresses. However, we do know that the disruptive stresses produced by the ordinary earthquake shock are tensile stresses. Therefore in laying out a design, an effort should be made to reinforce all the points at which the greatest tension is liable to be exerted. For example, an up and down motion, or a rocking motion, or a combination of the two, would produce in the beams and slabs of the floor systems extreme tensile stresses, not only on the lower side of such members, but in the upper side as well. Probably the maximum tensile stress in any horizontal member would be at one moment on the extreme fibers at the bottom, and the next moment in the extreme fibers at the top. Similarly the walls might receive tensile stresses, in either a horizontal or a vertical direction, one moment on the exterior face and the next moment on the interior face.

The foregoing considerations at once lead us to the conclusion that for a general safeguard against earthquake stresses, we should use what is known as "double reinforcement," that is, steel reinforcement in what are, under normal conditions, the tension and compression portions of the member. Of course a combination of tension and compressive reinforcement can never give the "maximum structural efficiency," and but seldom produces the greatest economy of cost. Nevertheless, it is becoming frequently remarked that many designers allow entirely too much compressive stress on the extreme fibers of a member subjected to flexure, and the use of compression reinforcement would tend to correct this error. Another incidental advantage would be the decrease in depth of the members of a floor system, allowing greater head-room, or if the head-room need be no greater, reducing the height of the building, and hence also reducing, not only the amount of concrete in the floor system itself, but also in the walls and columns.

As stated above, the cost of designing with "double reinforcement" would probably be greater than by using tension reinforcement only, on account of the additional amount of steel required, which would more than offset the saving of concrete. It would seem to be a question for the owner of the building to decide, whether the increased cost may not be warranted by the greater resistance to possible earthquakes.

This discussion brings us in conclusion to a consideration of the form of reinforcement that would be most appropriate for localities subjected to earthquakes. For floor systems, steel bars have been used for both compression and tension reinforcements, and it may be assumed that these bars will adequately provide for the tension produced by the reversal of stresses during an earthquake shock. Many designers would doubtless affirm that the same service could be performed in the case of concrete walls, by reinforcing with horizontal and vertical bars at both outer and inner surfaces. It is the writer's belief that the same resistance to tension could be obtained by the use of a form of netting, constructed by interlacing heavy steel wires, or by the use of some of the various forms of wire mesh, expanded metal, or the like, now manufactured for this purpose. But the resistance to tension is not the only feature of this kind of reinforcement. It is the resistance to *molecular deformation* that is just beginning to occupy the attention of designers in reinforced concrete in this country, although the theory was formulated some years ago by designers abroad.

Mr. C. F. Marsh in his work on reinforced concrete, Part V, writes as follows:

> It may be that we are wrong from the commencement in attempting to treat it (reinforced concrete) after the manner of structural iron. . . . The molecular theory, i. e., the prevention of molecular deformation by supplying resistances of the reverse kind to stresses on small particles, may prove to be the true method of treatment for a composite material such as concrete and metal.

In a very able paper by Mr. C. A. P. Turner, M. Am. Soc. C. E., published in the Proceedings of the American Society of Civil Engineers for March, 1906, the author discusses in considerable detail the advantages to be gained by reinforcing with interlacing wires to counteract this molecular deformation, and omitting the old fashioned tension and compression rods running in a single direction.

A very significant commentary on this new theory may be deduced from the experiments made by Prof. Ira H. Woolson, and published in the Engineering News some little time ago. The experiments referred to, demonstrated conclusively the fact that concrete in steel cylinders, subjected to compression in the direction of the axis of the cylinder, undergoes some sort of molecular change, as evidenced by the flowing action that takes place. The writer examined these specimens after the test, and observed that the deformed concrete, which had apparently flowed like lava, was nevertheless as hard and solid as in its original state.

It would seem to the writer that there is a wide, and practically unexplored field of investigation, for the mathematicians who will investigate the laws which must govern the resistance obtained in a concrete structure by reinforcing to prevent molecular deformation. The subject is one which should be attacked by mathematicians first, and by practical men afterward. With the rebuilding of San Francisco comes the necessity for an immediate solution of the problem, and it is the writer's belief that this solution is here indicated in a general way. The

hope that some one of the readers of the Engineering News will attack the problem quantitatively, is the writer's only excuse for the length of this discussion.

Respectfully yours, John Hawkesworth.

100 West 80th St., New York City, May 14, 1906.

REFUSE DESTRUCTOR COMBINED WITH ELECTRIC LIGHT PLANT AT WESTMOUNT, P. Q.

A combined refuse destructor and electric lighting plant is nearing completion at Westmount, P. Q., a residential town of some 12,000 inhabitants just outside the city limits of Montreal. A test of the destructor and connected boiler, made on May 3, is given in full herewith. On a test run of 8 hrs. 32 min. there were burned 37,550 lbs. of mixed refuse with an evaporation of 41,991 lbs. of water. This is at the rate of 1.12 lbs. of water to 1 lb. of refuse, under working conditions, or of 1.36 lbs. of refuse to 1 lb. of water from and at 212° F., and compares favorably with British tests of similar installations.

The destructor was designed and built by Meldrum Bros., of Manchester, England, represented in this country by Mr. W. F. Morse, of 18 Broadway, New York City. Mr. F. L. Fellowes is town engineer of Westmount, and Messrs. Ross & Holgate, of Montreal, served as consulting engineers to the town while the plans and estimates for the destructor and electric light plant were being made, erected the plant on the cost-plus-a-fixed-sum basis and tested the destructor for the town. The destructor proper, the boiler and various accessories were made abroad and shipped to Canada, and an engineer was sent from England by Meldrum Bros. to superintend the erection of the plant for them. Construction was begun in October, 1905, and by April 1, 1906, the destructor and electric light buildings, the Alphons Custodis chimney and the destructor and accessories were completed.

A Decaire refuse furnace was built at Westmount in 1900. It was operated for six months, under contract with the builders, but in 1901 its use was discontinued. From that time until a few weeks ago the town refuse was dumped on land.

PRELIMINARY ESTIMATES.

In September, 1904, Mr. F. L. Fellowes, town engineer of Westmount, reported to the mayor and council in favor of a three-grate top back and front feed Meldrum destructor, with a capacity of 20 long tons in 10 hours, and 50 tons in 24 hours, the destructor to supply heat to raise steam for a proposed municipal electric light plant. Estimates for the latter were made by Messrs. Ross & Holgate, as already stated. Mr. Fellowes' estimates provided for a steel and brick building, with charging platform of steel and concrete, stoking floor of concrete or other durable material, a refuse tipping platform house by wood encased with sheet iron, and a 20-ton (long) refuse hopper. Mention was also made in Mr. Fellowes' report of a "separator capable of sifting one load every two minutes, or 30 loads in one hour, operated by a 6-HP. motor," the separator to be placed between the tipping platform and destructor house. The separator has not been provided.

Fig. 1. View of Combined Municipal Refuse Destructor and Electric Light Plant, Westmount, P. Q.

(Electric light station at left; destructor and boiler house at right; driveway for refuse collection carts at extreme right.)

For the three years ending with 1903 the average total cost of refuse collection and disposal (by dumping on land) was $4,035 a year. There were employed five horses and carts in summer, six sleighs in winter, five drivers and two stable men. A total of 6,476 "loads" were collected "for the year" (1903?). It was thought that in future (not stated why) four carts would be sufficient. The cost of labor and fuel, for the proposed destructor, was estimated at 30 cts. per long ton.

In estimating capital costs and charges one-half of the cost of the destructor and boiler was charged to the electric lighting plant. Land, 55,000 sq. ft. in area, was included in the estimates, and a second set of estimates was submitted to show the effect of deducting from the land cost $5,500 for land previously bought for garbage disposal, and of charging 4% instead of 5% interest on the investment. It was estimated that the refuse burned in the destructor during a year would be equivalent to 1,042 long tons of coal, and there was credited to destructor operation 1,000 long tons of coal, at $4 per ton.

Mr. Fellowes' estimates of capital and operating costs follow:

PRELIMINARY ESTIMATES OF CAPITAL AND OPERATING CHARGES, REFUSE DESTRUCTOR, WESTMOUNT, P. Q., ON BASIS OF TWENTY LONG TONS BURNED PER DAY.

STATEMENT NO. 1.

	Cost.	Interest. 5%.	Depreciation, 5%.	Repairs. 1½%.
Land	$19,160	$958.00		
Incinerator	19,000	950.00	$950.00	$285.00
Foundations	3,000	150.00		
Building	3,500	175.00	175.00	52.50
Switches, bldgs., scales, etc.	16,408	820.40	3% 492.24	246.12
	$61,068	$3,053.40	$1,617.24	$583.62

Operating Expenses.		Credit 1,000 tons coal.	
Interest	$3,053.40	By sale of HP. energy to lighting plant at $4 per ton	$4,000.00
Depreciation	1,617.24		
Repairs	583.62	By clinker sold to road department	250.00
Two laborers.	939.00		
One stoker	730.00		
One cart and horse	637.00	Total	$4,250.00
	$7,560.26	Total tons destroyed = 6,476.	
Credit	4,250.00	Total operating exp. = $3,310.26	
	$3,310.26	$3,310.26 ÷ 6,476 = 51.1 cts. per ton.	

STATEMENT NO. 2.

	Cost.	Interest. 4%.	Depreciation, 5%.	Repairs.
Land*	$13,660	$546.40		
Incinerator	19,000	760.00	$950.00	$285.00
Foundations	3,000	120.00		
Buildings	3,500	140.00	175.00	52.50
Railway switch, scales, bldgs. etc.	16,408	656.32	820.40	246.12
	$55,568	$2,222.72	$1,945.40	$583.62

*Credit 55,000 ft. of land at 10 cts. = $5,500.

Operating Expenses.		Credit 1,000 tons coal.	
Interest	$2,222.72	By sale of HP. energy to lighting plant at $4 per ton	$4,000.00
Depreciation	1,945.40		
Repairs	583.62	By clinker sold to road and walks	250.00
Two laborers.	939.00		
One stoker	730.00		
One cart and horse	637.00	Credit	$4,250.00
	$7,057.74	Total tons destroyed per year = 6,476.	
Credit	4,250.00	Total operating exp. = $2,807.74	
	$2,807.74	$2,807.74 ÷ 6,476 = 43.3 cts. per ton.	

STATEMENT NO. 3.

Cost of Cartage and Collecting.—Present System.

Five carts and horses.
Total number tons per year, 6,476.
Total average cost per year, $4,035.29 for three past years.
Total cost per ton load under present system, 62.3 cts.
Cost per horse and cart teamster, $637.

Cost Under New System.

Four carts and horses.
Cost after deducting one horse and cart, $3,398.29.
Cost per ton at incinerator, 52.4 cts.
Average load—2,000 lbs. = 1 ton.

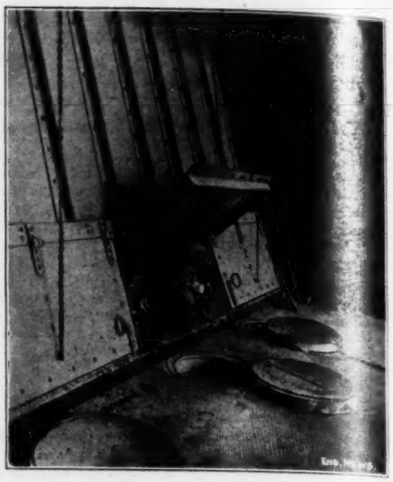


Fig. 2. Bottom of Steel Refuse Hopper and Top Feed Holes of Destructor.

Statement No. 1: Cost of destruction.....51.1 cts.
Cost of cartage and collection..52.4 cts.
Total cost per ton..... $1.03½

Statement No. 2: Cost of destruction.....43.3 cts.
Cost of cartage and collection..52.4 cts.
Total cost per ton.....95.7 cts.

STATEMENT NO. 4.

	Plan A.	Plan B.
Total cost, combined system	$6,708.55	$6,206.03
Total cost, present system	4,035.29	4,035.29
Increased annual cost to provide for	$2,673.26	$2,170.74

The estimates for the lighting plant made by Ross & Holgate may be summarized as follows: Population, 10,000; houses, 2,000, of which 1,000 would be wired; lights installed, 10,000; arc lamps for streets, 150; plant large eonugh for 2,000 houses. The estimated capital outlay for the combined plant, including 10% for contingencies, was $129,884 for electric lighting and $67,175 for the refuse and refuse power plant, making a grand total of $197,058. This amount, we are informed, "will in all probability be larger" than the sum "actually expended."

THE DESTRUCTOR AND ACCESSORIES AS BUILT.

The essential features of the destructor and accessories are quite fully shown by the accompanying views, plans and sections, and by the descriptive matter in the report on the tests. From the view, Fig. 1, it may be seen that the plant is located at the foot of a hill, so the refuse carts can be hauled to the tipping platform without surmounting the usual grade, while the refuse from the hoppers may be dropped into the grates, and the clinker from the latter may be dropped through the stoking floor for removal by wagons from that level.

The refuse hopper (Figs. 2 and 5) is of steel, with lifting doors at the bottom, close to the destructor feed holes. Figs. 3 and 4 show the fronts of the destructors and of the destructor boilers, respectively, while Fig. 5 shows a plan and section of the plant. Doors are provided at the rear for pushing the refuse forward onto the hot fire, thus making it more comfortable for the feed men and lessening the time that the front doors, close by the hot fire, need be open.

A regenerator, close by the boiler, utilizes the waste gases, after these have passed through the boiler for preheating the air for the forced blast which is introduced beneath the grates, as shown in Fig. 5.

One boiler is supplied with heat from the refuse destructor and has no grates. Two hand fed-coal-fired boilers are provided. It was estimated, in 1904, that the destructor would furnish sufficient heat for the electric light load from 1 a. m. to daylight, but at present the refuse is being burned in the day time and is supplying energy for the day load, no coal being used except at night, when the lighting comes on.

Fig. 3. Front View of Destructor, Showing Stoking and Ash Pit Doors and Trap Doors for Clinker.

Fig. 4. Refuse-Fired 200-HP. Babcock & Wilcox Boiler.
(Peep hole to destructor is shown in the brick wall at the right.)

FIGS. 3 AND 4. MELDRUM REFUSE DESTRUCTOR AND BOILER SUPPLIED THEREFROM AT WESTMOUNT, P. Q.

TEST OF THE DESTRUCTOR AND ITS BOILER.

There follows a copy of the report of a test of the destructor, made by Messrs. Ross & Holgate (see also diagram, Fig. 6):

REPORT OF TEST OF MUNICIPAL REFUSE DESTRUCTOR, WESTMOUNT, P. Q., MAY 3, 1906.
(Copy.)

W. L. Lee, Esq., Chairman of the Light Committee of the Corporation of Westmount, Star Building, Montreal.

Dear Sir: Since April 12, 1906, the refuse destructor built by Messrs. Meldrum Bros., in connection with your municipal lighting plant, has been successfully destroying all refuse brought to it, in quantities averaging about 30 loads per day, the average weight of a load being about 1,500 lbs. This has usually been burned in 10 to 12 hours, giving an average burning capacity to the destructor of about 4,500 lbs. per hour, or a little over two tons. During several days this amount has been exceeded, and we have therefore no hesitation in saying that the makers' guarantees of 50 tons per 24 hours can be attained, with proper firing. In order to officially test the plant, however, on May 3 a staff of our engineers went to Westmount, and conducted a special test run as follows:

OBJECT OF TEST.—The test was conducted to try the burning and evaporative powers of the Meldrum Bros.' three-grate refuse destructor when fired with unscreened mixed refuse, and connected to a Babcock & Wilcox boiler of 2,197 sq. ft. of heating surface, and also to test the makers' guarantees regarding completeness of combustion, quality of residual clinker, temperatures in various parts of the destructor, etc., etc.

APPARATUS USED.—The following apparatus and instruments were made use of:

(1) Meldrum destructor with regenerator, steam jet blowers, etc.
(2) B. & W. water tube boiler of 2,197 sq. ft heating surface, and with superheater and the necessary pipes to engine, atmosphere, etc.
(3) Orsat apparatus for analyzing flue gases.
(4) U-tube gages for ashpit pressures and chimney pull.
(5) Dial thermometers for gas temperatures entering and leaving regenerator.
(6) Stem thermometers for hot air, cold air and feed water temperatures, etc.
(7) Aneroid barometer for atmospheric pressure.
(8) Public standard scales for weighing refuse, clinker, tins, etc., and also for calibrating the barrels used for measuring the feed water.
(9) Knowles 6 × 4 × 6 duplex pump for feeding boiler, equipped with Williams Gage Co.'s automatic feed regulator.
(10) Watkins heat recorders for combustion chamber temperatures.

DURATION OF TEST.—The test proper commenced at 10 a. m. and ended at 6.32 p. m., or continued for 8 hrs. and 32 min.

CONDITIONS OF OPERATION. Weather: Wednesday, May 2, was raining all day and all night. Thursday, May 3, was raining in morning until 11.30, when rain stopped and wind got up. Afternoon was warm and sunny.

Apparatus: The destructor gases fired the B. & W. boiler, and the steam was used to drive a 130-HP. Robb Engineering Co.'s simple non-condensing engine, belted to a temporary 75-KW. monocyclic generator carrying the day load of the town, which is a purely residential district, and therefore has a light day load. As this was light the whole power was not used, and the steam was blowing off to the atmosphere from the boiler almost continually.

Men: The following staff comprised the personnel of the test: Four men operating the destructor; one man attending to feed water; one man reading pressures and temperatures; one man checking weights and measures and taking gas analysis; one superintendent of test.

METHOD OF MAKING TRIAL.—The corporation [municipal] carts dumped the garbage into the large storage bin which had been cleaned out over night, and gave the checker the weight ticket as the cart was emptied. All large tins and unburnable refuse was picked out and put to one side and weighed separately afterwards. Fires were started at 7.55 a. m. with a light supply of old wood and a little coal, on clean grates, and kept in until 9.50, when the first weighed loads were dumped into the hopper. Firing with garbage commenced at 10 o'clock with the destructor warmed up, two men raking the refuse from the bin into the charging holes and two men at the same time leveling the charge from the rear. Each fire was charged in turn, its steam blast being shut off during this process. After burning for about two hours (during which period fresh garbage was added to each fire every 20 minutes) the mass was thoroughly clinkered, and it was then withdrawn from the front and dropped through the floor into the clinker pit below, whence it was removed to be weighed. Tins, etc., were also deposited in this bin for weighing. Fires were each clinkered three times. When the fires were well burned down and ready to clinker for the third time the test was ended, the burnt clinker being left on the grate bars over night to keep the destructor warm for the next day's operation. This clinker was drawn and weighed the first thing Friday morning.

The boiler was fed through the Knowles pump and Williams regulator, and the level of the water in the drums was maintained practically constant throughout the test. The water for the test was pumped from a barrel submerged in the hotwell and fed from two barrels so arranged as to be filled and emptied alternately. The quantity was very carefully watched, and the barrels gaged very closely. Readings of pressures and temperatures were taken every fifteen minutes, gas analyses were taken several times during the run, and combustion chamber temperatures were read about six or seven times under different conditions. At the end of the trial the conditions were as nearly as possible the same as at the beginning, the water level in the boiler being the same, as well as in the hotwell, and all other conditions were carefully watched and attended to.

RESULTS OBTAINED.—The following table shows in condensed form the averages of the results obtained, and the attached curves [Fig. 6], etc., show these in extenso:

Duration of test	8 hrs. 32 min.	
Number of cells	3	
Total grate area	75 sq. ft.	
B. & W. Boiler, heating surface	2,197 sq. ft.	
Refuse consumed (composition of waste material):		
Garbage, manure and leaves		15%
Ashes and unburnt [anthracite] coal, cinders, etc.		65%
Iron, wood, bottles, tins, leather, etc.		5%
Refuse, including paper, branches, old furniture, etc.		15%
Total		100%
Weights.		
Unscreened refuse, rubbish, garbage, manure, etc	38,000	lbs.
Tins, etc., not burned	540	"
Net amount consumed	37,550	lbs.
Refuse consumed per hour	4,402	"
Refuse consumed per hour per sq. ft. of grate	58.7	"
Weight of clinker remaining after combustion	15,880	"
Percentage of clinker and ashes to refuse consumed	42.1%	

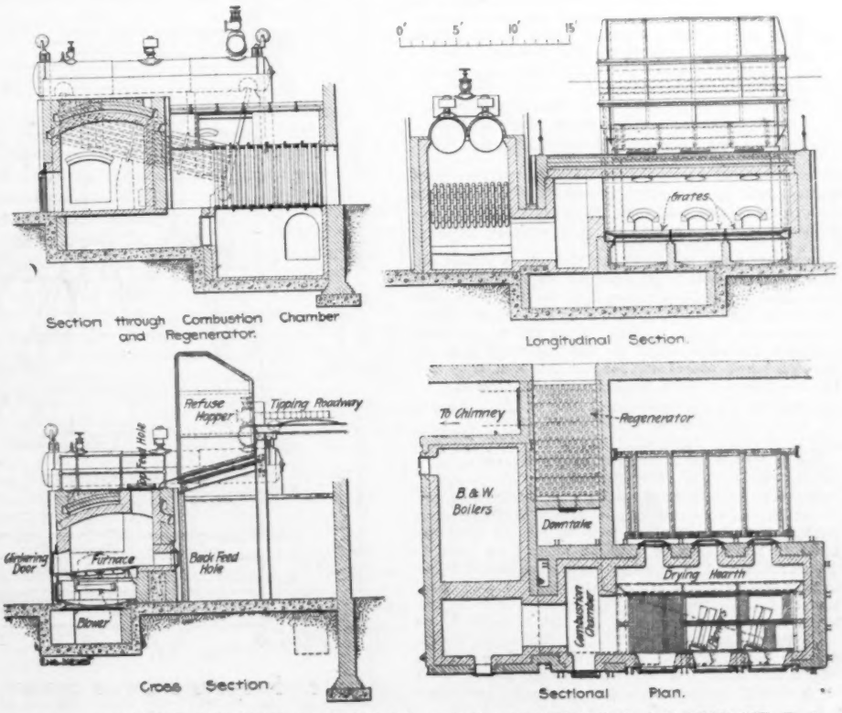


FIG. 5. PLAN AND SECTIONS OF MELDRUM REFUSE DESTRUCTOR, WESTMOUNT, P. Q.

Water Evaporation.		
Total water evaporated	41,991	lbs.
Water evaporated per hr., actual	4,920	"
" " " " from and at 212° F.	5,970	"
" " " lb. of refuse, actual	1.12	"
" " " " of refuse, from and at 212° F.	1.36	"
Water evaporated per lb. of refuse from and at 212° F. and per sq. ft. of total heating surface per hr.	2.72	"
Pressures and Temperatures.		
Temperature of the outside air, average	55° F.	
Barometric pressure, average	29.5 ins.	
Average steam pressure	123.5 lbs. sq. in.	
" pressure in ash pits	1.74 ins.	
" vacuum at chimney base	9/16 in.	
" temperature of combustion chamber (by Watkins heat recorders)	over 1,994° F.	
Highest temperature of combustion chamber, (Copper melted in 1¼ minutes—wrought iron was also fused.)	over 2,318° F.	
Lowest temperature in combustion chamber	1,742° F.	
Average temperature of air entering regenerator.	75° F.	
" " of air leaving regenerator	206° F.	
" " of gases entering regenerator	427.5° F.	
Average temperature of gases leaving regenerator	333.7° F.	
Average temperature of feed water	47° F.	
Gas Analysis.		
Percentage of CO_2 average of six readings	10.9%	
" " highest reading	13.6%	
" " lowest reading (clinkering fires).	4.5%	
Times.		
Time taken to clinker one grate	10½ min.	
Time between clinkerings	2 hrs. 48	"
Times each fire was clinkered	Three	

REMARKS. A delay of about three-quarters of an hour was caused by non-delivery of garbage in the early part of the afternoon, during which time no fresh charge was added to the fire. Had this not been the case the total quantity of refuse could easily have been destroyed within eight hours, as the fires had to be held back somewhat on this account, and a somewhat better showing could have been made in the burning powers of the destructor had sufficient garbage been delivered to force it to its utmost capacity.

An interesting feature of the trial was the good feed water regulation, neither pumps nor valves being touched during the whole test.

Some idea of the great heat generated when the fires are in full blast may be obtained from the fact that at one time a piece of copper tubing 1½ ins. long × 1 in. in diameter × 3/32 in. thick was completely volatilized in 1¼ mins. upon being placed in the combustion chamber, and a wrought iron horseshoe was picked out from the clinker heap which was fused in several places. (Wrought iron fuses at 2,912° F.) The same thing happened to an earthenware pot made of refractory material.

The clinker produced was hard and vitreous, and was fused into large masses of great density. Almost no smoke was visible from the chimney top, and all noxious gases were conspicuous by their absence. The analysis of the flue gases shows how complete the combustion was, except during the process of clinkering, when the large doors of the furnaces being open let in a large amount of air.

In consideration of the foregoing, we are very pleased to state that in our opinion the destructor has fulfilled all the requirements of our specifications, and has also demonstrated the makers' guarantees satisfactorily, and we have much pleasure in recommending its acceptance.

Trusting that the above will meet with your approval, we are, Yours faithfully,

Ross & Holgate,
Consulting and Supervising Engineers.

80 St. Francis Xavier St., Montreal, May 4, 1906.

In response to a request for a statement of capital cost and conditions and cost of operation of the destructor Messrs. Ross & Holgate have very kindly sent us the following information:

CAPITAL COST OF DESTRUCTOR.—It is almost impossible at this date to say what the cost of the building, land, bins, etc., fairly chargeable to the destructor itself will be, as the whole equipment of boilers and destructor, together with coal and garbage storage and the necessary accessories, is contained in one building which is as yet unfinished and whose cost has not yet been separated, but the following items are approximately correct:

Meldrum three-grate destructor, about	$14,000.00
B. & W. water-tube boiler connected to destructor, about	4,500.00
Custodis chimney, total cost, about	6,000.00

(Only partly chargeable to the destructor as it is common to all three boilers.)

OPERATING EXPENSES.—There are four men employed in the operation of the destructor for feeding, leveling and clinkering, as well as looking after the boiler, but this number may be reduced to three in the near future. The wages paid are: One man at 25 cts. an hour and three men at 20 cts. an hour. The 20 [long] tons of garbage per day are disposed of in about ten hours, so that at present only one shift is required and the labor charge for destruction amounts to about 42½ cts. per [long] ton. Of course, there will be quite a considerable amount of steam sold to the electric plant which must be credited to the destructor and some clinker and other by-products will also be sold.

NET UNIT COST.—To obtain the net cost of destruction the capital charges and labor costs must be added, and the sum of the amounts obtained from the sale of steam and by-products subtracted from the total. The net costs so found, divided by the tons consumed per year, will give the average cost per ton.

After page 586 had gone to press we received the following corrections from Mr. Fellows: Population of Westmount, 11,000. Refuse formerly hauled three miles, to neighboring town; new destructor within town of Westmount, thus shortening the haul. In preliminary estimates of cost one-half cost of destructor house, instead of destructor, charged to electric lighting plant.

Brief comment on the Westmount destructor and the foregoing tests may be found in our editorial columns.

CEMENT FOR BUILDING CONSTRUCTION.*

The rapidly extended use of concrete for a great variety of purposes, such as retaining walls for embankments, bridges of intricate design, reservoirs, stand-pipes, sewer work, grain tanks, coal bins, piers, fence posts, railway ties and buildings or almost any part thereof, even including shingles, has naturally resulted in bringing to the study of the subject a great many men of ability. A very gratifying progress has been made and the average concrete building of to-day is much less open to criticism and is a correspondingly better fire risk than the building of a few years ago.

CONCRETE BLOCK CONSTRUCTION.—The use of concrete blocks has rapidly increased until now they are common in practically every part of the country, and there are at least 100, and probably more, kinds of machines on the market for making blocks of one sort or another.

On account of lack of experience of their manufacturers, the concrete blocks as found to-day throughout the country vary largely in appearance, strength, waterproof quality and doubtless also in fire resistance. Some of those examined by members of this committee have every indication of being strong and durable and at least the equal in fire resistance of natural limestone, but many others appear very porous and weak, and some which have been submitted to members of this committee for fire tests have actually disintegrated in the course of a few months while waiting for trial.

The form in which most of these small blocks are made involves a certain weakness under severe temperatures which, while by no means fatal to the fire resistance, places a limitation on that quality which must be recognized; namely, they are subject to breakage by unequal expansion under heat, the same as is hollow tile or any other similar hollow material. Hollow blocks of concrete or tile as set in the walls or floors of a building usually present only one surface to the direct attack of fire, and the consequence is that that side or face of the block expands readily and irresistibly under the influence of the heat, while the other three sides receiving much less heat do not expand nearly so rapidly, with the result that the hottest side breaks away from the others. This has been demonstrated in actual fires and experimental tests for both concrete and tile. Failure from this cause would naturally occur soonest in blocks having a thin shell, inasmuch as the thinner the shell of the block towards the fire, the more quickly it will heat through and consequently expand. This breaking by unequal expansion has sometimes been referred to as a bursting due to pressure of steam or gases generated in a large hollow space or cell of the block, but a very brief analysis of the conditions will easily disapprove any such statement. In the first place, there is generally no means of getting water into the interior of a block and no probability of gases from other sources being introduced therein, but if it were possible to get gas or steam into the interior, these cells are so continuous in a wall or floor and have so many vents to the atmosphere at the top of the wall or through mortar joints that the accumulation of the pressure necessary to burst an ordinary small block would be an impossibility under working conditions.

REINFORCED CONCRETE CONSTRUCTION.—Many questions as to the best design of reinforcement and methods of computing dimensions and values of the various parts of a beam, column or other member are still under discussion between engineers, and investigation is still in progress as to the relative fire resistance of concrete made of various materials and different proportions of mixture, so we are not yet prepared to specify the entire detail of construction which might come within the range of the general requirement of proper design and adequate insulation. We would like to emphasize again, however, the fact that a concrete building even if designed along the most approved lines of the present day engineering may be very good or very poor as to fire resistance according as the selection of materials and execution of the entire work is intelligently and honestly carried out or otherwise.

During the past year the National Board of Fire Underwriters has recommended a "Building Code," which includes a standard for concrete construction which is appended. In the preparation of this standard the National Board Committee secured the best expert advice and presents this as the best obtainable up to this time, but expects to revise it from time to time as future experience may warrant.

The term "reinforced concrete" or "concrete-steel" in this section shall be understood to mean an approved concrete mixture reinforced by steel of any shape, so combined that the steel will take up the tensional stresses and assist in the resistance to shear.

Reinforced concrete construction may be accepted for fireproof buildings, if designed as hereinafter prescribed; provided, that the aggregate for such concrete shall be hard-burned broken bricks, or terra cotta, clean furnace clinkers, entirely free of combustible matter, clean

*Abstract of a committee report presented at the annual meeting of the National Fire Protection Association in Chicago, May 22, 24.

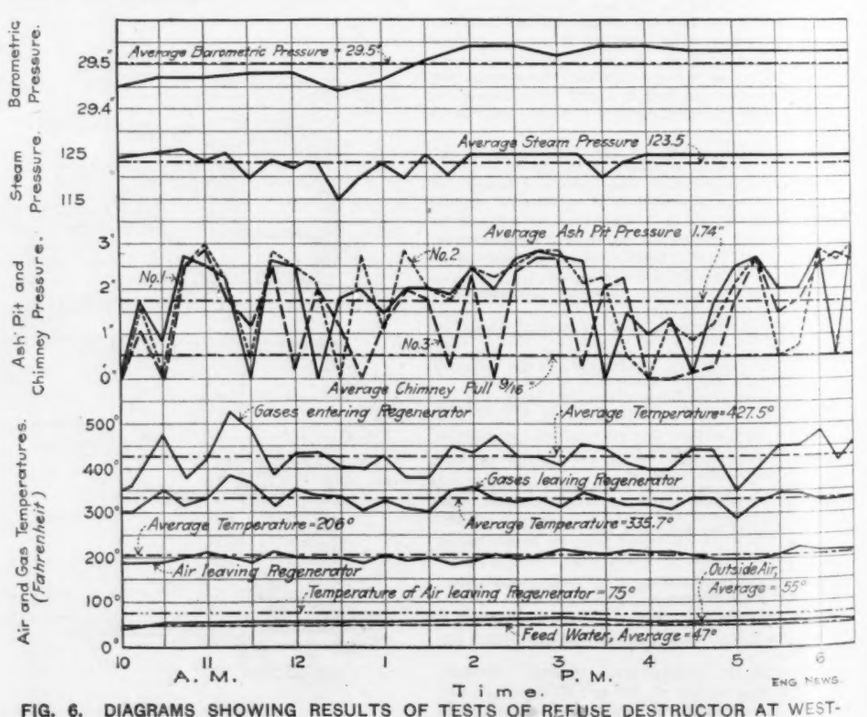


FIG. 6. DIAGRAMS SHOWING RESULTS OF TESTS OF REFUSE DESTRUCTOR AT WESTMOUNT, P Q.

broken stone or furnace slag, or clean gravel, together with clean siliceous sand, if sand is required to produce a close and dense mixture; and, provided further, that the minimum thickness of concrete surrounding and reinforcing members ¾-in. or less in diameter shall be 1 in., and for members heavier than ¾-in. the minimum thickness of protecting concrete shall be four diameters, taking that diameter, in the event of bars of other than circular cross-section, which lies in the direction in which the thickness of the concrete is measured; but no protecting concrete need be more than 4 ins. thick for bars of any size; and provided, further, that all columns and girders of reinforced concrete shall have at least 1 in. of material on all exposed surfaces over and above that required for structural purposes; and all beams and floor slabs shall have at least ¾-in. of such surplus material for fire-resisting purposes; but this shall not be construed as increasing the total thickness of protecting concrete as herein specified.

All the requirements herein specified for protection of steel and for fire-resisting purposes shall apply to reinforced concrete filling between rolled-steel beams, as well as to reinforced concrete beams and to entire structures in reinforced concrete. Any concrete structure or the floor filling in same reinforced or otherwise, which may be erected on a permanent centering of sheet metal, of metal lathing and curved bars or a metal centering of any other form, must be strong enough to carry its loads without assistance from the centering, unless the concrete is so applied as to protect the centering as herein specified for metal reinforcement.

Exposed metal centering or exposed metal of any kind will not be considered a factor in the strength of any part of any concrete structure, and a plaster finish applied over the metal shall not be deemed sufficient protection.

All concrete for reinforced concrete construction whenever used in such buildings must be mixed in a machine which mixes one complete batch at a time, and entirely discharges it before another is introduced. At least 25 complete revolutions must be made at such a rate as to turn the concrete over at least once in each revolution for each batch.

Before permission to erect any concrete-steel structure is issued, complete drawings and specifications shall be filed with the Commissioner of Buildings, showing all details of the construction, the size and position of all reinforcing rods, stirrups, etc., and giving the composition of the concrete.

The execution of work shall be performed by workmen under the direct supervision of a competent foreman or superintendent.

The concrete shall be mixed in the proportions of 1 of cement, 2 of sand and 4 of other aggregates as before provided; or the proportions may be such that the resistance of the concrete to crushing shall not be less than 2,000 lbs. per sq. in. after hardening for 28 days; but for reinforced or plain concrete columns the mixture shall not be leaner than 1 part of cement, 2 of sand and 5 of the coarser aggregate in any case. The tests to determine this value must be made under the direction of the Commissioner of Buildings. The concrete used in concrete-steel construction must be what is usually known as a "wet" mixture.

Only high-grade Portland cements shall be permitted in reinforced concrete or concrete-steel constructed buildings. Such cements, when tested neat, shall, after one day in air, develop a tensile strength of at least 300 lbs. per sq in.; and after one day in air and six days in water shall develop a tensile strength of at least 500 lbs..; and after one day in air and 27 days in water shall develop a tensile strength of at least 600 lbs. Other tests, as to fitness, constancy or volume, etc., made in accordance with the standard method prescribed by the American Society of Civil Engineers, may, from time to time, be prescribed by the Commissioner of Buildings.

The sand to be used must be clean, sharp grit sand, free from loam or dirt, and shall not be finer than the standard sample kept in the Department of Buildings.

The stone used in the concrete shall be a clean, broken stone, of a size that will pass through a ¾-in. ring, or good gravel may be used in the same proportion as broken stone, or broken hard bricks, or terra cotta, or furnace slag, or hard clean clinkers may be used.

The steel shall meet the requirements of Section 21 of this Code.*

Concrete-steel shall be designed in accordance with the following assumptions and requirements:

(1) The adhesion between the concrete and the steel is sufficient to make the two materials act together; the unit value of the adhesion is at least equal to the unit shearing strength of concrete.

(2) The design shall be based on the assumption of a load four times as great as the total working load (ordinary dead load plus ordinary live loads) producing a stress in the steel equal to the elastic limit, and a stress in the concrete equal to 2,000 lbs. per sq. in.

(3) The modulus of elasticity of concrete at 2,000 lbs. per sq. in. is equal to 1-18th of the modulus of elasticity of steel.

(4) The steel takes all the tensile stress.

(5) The stress-strain curve of concrete in compression, when the stress in the extreme fiber is 2,000 lbs. per sq. in. may be assumed.

(a) As a straight line.

(b) As a parabola with its axis vertical and its vertex on the neutral axis of the beam, girder or slab, or

(c) As an empirical curve with an area one-quarter greater than if it were a straight line, and with its center of gravity at the same height as that of the parabolic area assumed in (b).

(6) The assumption belonging to the common theory of flexure, where not modified by any of the foregoing, will apply.

In the design of structures involving reinforced concrete girders and beams, as well as slabs, the girders and beams shall be treated as T-beams, with a portion of the slab acting as flange, in each case. The portion of the slab so acting shall be determined by assuming that in any horizontal-plane section of the flange, the stresses are distributed as the ordinates of a parabola, with its vertex in the stress-strain curve and with its axis in the longitudinal vertical plane through the center of the rib of the T.

The shearing strength of concrete, corresponding to a compressive strength of 2,000 lbs. per sq. in.. shall be assumed at 200 lbs. per sq. in.

*Section No. 21.—All structural steel shall have an ultimate tensile strength of from 54,000 to 64,000 lbs. per sq. in. Its elastic limit shall be not less than 32,000 lbs., and test specimens, ruptured in tension, must show a minimum elongation of not less than 20% in 8 ins. Rivet steel shall have an ultimate strength of from 50,000 to 58,000 lbs. per sq. in.

All reinforced concrete T-beams must be reinforced against the shearing stress along the plane of the junction of the rib and the flange. Where reinforced concrete girders carry reinforced concrete beams, the portion of the floor slab acting as flange to the girder must be reinforced with bars near the top, at right angles to the girder, to enable it to transmit local loads directly to the girder and not through the beams, thus avoiding an integration of compressive stresses due to simultaneous action as floor slab and girder flange.

Concrete indirect compression shall not be stressed, under the working load, more than 350 lbs. per sq. in. Reinforced compression members shall be designed on the assumption that this stress in the concrete will be simultaneous with one of 6,000 lbs. per sq. in. in the steel. Should the use of hooped concrete as proposed, the working stresses will be a subject for special consideration by the Commissioner of Buildings.

In the execution of work in the field, work must be so carried on that the ribs of all girders and beams shall be monolithic with the floor slab.

In all reinforced concrete structures, special care must be taken with the design of joints to provide against local stresses and secondary stresses due to the continuity of the structure.

In the determination of the bending moments due to the external forces, beams and girders shall be considered as simply supported at the ends, no allowance being made for continuous construction over supports. Floor plates, when constructed continuous and when provided with reinforcement at top of plate over the supports, may be treated as continuous beams, the bending moment for uniformly distributed loads being taken at not less than $\frac{W\,L}{10}$; the bending moment may be taken at $\frac{W\,L}{20}$ in the case of square floor plates which are reinforced in both directions and supported on all sides.

When the shearing stresses developed in any part of a reinforced concrete or concrete-steel constructed building exceed under the multiplied loads, the shearing strength as fixed in this section, a sufficient amount of steel shall be introduced in such a position that the deficiency in the resistance to shear is overcome.

When the safe limit of adhesion between the concrete and steel is exceeded, provision must be made for transmitting the strength of the steel to the concrete.

Concrete-steel may be used for columns in which the ratio of length to least side or diameter does not exceed twelve. The reinforcing rods must be tied together at intervals of not more than the least side or diameter of the column.

The contractor must be prepared to make load tests on any portion of a reinforced concrete or concrete-steel constructed building within a reasonable time after erection as often as may be required by the Commissioner of Buildings. The tests must show that the construction will sustain a load with a factor of safety for floors and structural members as required by Section 136 of this Code.

NOTES FROM THE ENGINEERING SCHOOLS

PURDUE UNIVERSITY.—The Schools of Engineering are being enlarged and new equipment purchased, in order to provide better facilities for engineering work. At the opening of the next college year the School of Civil Engineering will be located in a new building and an addition to the Electrical Laboratory will have been completed, which will provide for an electric crane and housing of the test car "Louisiana," this being the car that was built by the American Street and Interurban Railway Association for test at the St. Louis Exposition. The Mechanical Engineering Laboratory is also receiving new equipment, some of the most important pieces being an Ingersoll-Rand No. 10 Imperial steam-driven compound duplex air compressor, a 50-HP. Fairbanks-Morse gas producer with gas engine, a Power Specialty Co.'s superheater, an Allis-Chalmers direct-connected Corliss engine and centrifugal pump, a De Laval steam turbine direct-connected to centrifugal pump, and a 100-HP. compound marine engine with all auxiliary apparatus.

UNION COLLEGE.—Mr. Edgar B. Van Winkle, Consulting Engineer of New York and a member of the class of '61 of the Union College engineering school, has just purchased the library of the late Jas. J. R. Croes and donated it to Union College. This library, which Mr. Croes collected during his long professional life, is extremely rich in standard works, monographs and professional reports in hydraulic engineering.

This is the second recent important addition to the engineering library of Union College—Mr. Edward P. North, Consulting Engineer, of New York, and a member of the class of '56 of the Union College engineering school, having about a year ago donated a portion of his extensive engineering library.

THE SAN FRANCISCO EARTHQUAKE AND FIRE conditions are briefly reviewed by Mr. F. H. Porter, Chief Inspector of the Fire Underwriters' Inspection Bureau, at San Francisco, in a letter dated April 29, which has been distributed in circular form by the National Fire Protection Association. The letter is given below, practically in full:

Except that the loss of life is exaggerated, no report that you may have can be worse than the reality. At this date, 10 days after the fire, we are without water to protect what is left of San Francisco (one tap in each block for domestic supply only), without a fire alarm system, have neither power nor light, can cook only in the street, are without transportation and still under martial law.

The necessity for directing every energy to the prevention of the use of fire in the remaining buildings, and for inspecting as rapidly as possible the remaining kitchen chimneys so as to get people off the streets when water becomes available, will prevent any systematic personal investigation of the effects of the earthquake and fire, jointly or severally. It is apparent, however, that the protected steel frame buildings suffered but trifling damage from the earthquake, and the wooden buildings suffered little unless very old. The buildings of fireproof construction burned very slowly and where the top floors and trim were not of wood suffered comparatively small damage. No building of the protected steel class with wood top floors, wood frames and sashes, and wood trim has any chance of withstanding a general conflagration with less than 70% damage.

The earthquake started at once a large number of fires in the business section and at the same time destroyed the large water mains supplying the reservoirs. The supply in the reservoirs and street mains appears to have been dissipated by the simultaneous breaking of thousands of building services as well as by damage to street mains, which latter can as yet be only guessed at. At this date there is apparently sufficient water coming into the city for all, but with the burned district shut off no water accumulates in the reservoirs and there is but little in the street mains in some sections of the city and none in others. While an independent water supply for fire purposes only would not have suffered from broken service connections, it is impossible at this writing to say whether or not such mains would have retained efficiency.

The stopping of this fire in the best residence section at a wide boulevard with only dynamite and a trifle of water (all buildings frame on boulevard), shows the value of such a wide street. We hope to get in several in the rebuilding of the burned district.

EMERGENCY REPAIRS TO THE SAN FRANCISCO Water-Works after the earthquake of April 18 are briefly described in the San Francisco "Chronicle" of May 14. Mr. Herman Schussler, Chief Engineer of the Spring Valley Water Co., is quoted as follows:

Early on Wednesday morning I was informed that our entire pipe-line system from our sources of supply was gone. The entire flow of 36,000,000 gals. had stopped as quickly as though the pipes had been plugged. At that moment I knew there was only 60 hours' supply in the city, and that with a big fire and our city mains broken. Maybe the Spring Valley boys did not work that day. A hurried view of the situation showed that the Lake Merced line might be more quickly repaired, and a force was concentrated there. We maintain our own repair shops, and by 9 o'clock on Wednesday night, just 16 hours after the break, Lake Merced was pouring 7,000,000 gals. into the city, and the Western Addition was safe. Within the next 60 hours we had repaired the break in the San Andreas line temporarily, and were sending in 5,000,000 gals. more by that line to the College Hill reservoir.

THE PLANS FOR A $162,000,000 ADDITIONAL water supply from the Catskill Mountains for New York City, as proposed in October, 1905, by the Board of Water Supply of the City of New York, were amended and approved on May 14 by the State Water Supply Commission. The right to take water from the Schoharie drainage area is denied, because the city failed to give statutory notices in Montgomery and Schenectady Counties. The plans are also amended to exclude the taking of water from that portion of Mink Hollow stream used as a public water supply by the city of Kingston, and to permit any municipality within the drainage areas of Esopus, Rondout and Catskill creeks, within the State, to take water from the new system, on payment therefor. Indirectly the original plans have also been modified by legislative amendments to existing laws designed to safeguard property owners, and providing for indirect damages to persons whose property is taken, business affected, or who are thrown out of employment by the taking of property for the new water supply. The State Water Supply Commission recommends that New York City take steps to remove the legislative prohibitions against taking water from Suffolk and Dutchess Counties (beyond the Brooklyn and Croton supplies, respectively); also that it try to remove interstate complications interfering with taking water from Ten Mile River, a portion of the drainage area of which is in Connecticut, and that it take steps to prevent the waste now going on in New York City. During the time that its plans have been before the State Commission (nearly seven months) the Board of Water Supply has been proceeding with its preliminary work. There seems to be nothing now to prevent the board from entering upon the execution of its plans. It is estimated that five years will be required to deliver water from the new source into the Croton supply, and several years in addition before more water can be delivered in New York than can be brought in through the old and new Croton aqueducts.

THE GARBAGE REDUCTION WORKS of the New York Sanitary Utilization Co., on Barren Island, Jamaica Bay, were destroyed by fire on Sunday, May 20. The loss is placed at $1,000,000. The original works were put in partial operation in December, 1896, prior to consolidation with Brooklyn. Shortly afterwards the same company, in effect, built a second and adjoining plant, under a contract with the city of Brooklyn. The two plants have been run virtually as one, and as such

have formed the largest garbage disposal works in the world. As early as 1900 they had a rated normal capacity of 1,000 tons a day, and it was stated that they had been operated at 1,500 tons a day for brief periods in summer. The Arnold or Arnold-Edgerton process was employed, in which the garbage was cooked in 150 steel digestors, pressed and dried. The commercial products were grease and fertilizer base. A large quantity of fertilizing material was burned at the fire, but the grease in storage was saved. A lengthy illustrated description of the plant may be found in Engineering News for Feb. 1, 1900. Pending reconstruction, it will be necessary to resume the dumping of garbage at sea.

DEFECTS IN THE EAST RIVER TUNNEL of the New York Rapid Transit Railway extension to Brooklyn have developed and will be made the subject of an early special report to the Rapid Transit Commission. The exact nature and extent of the defective work is not clear from the statements that have been so far made public, but it appears that the tunnel departs from true alinement in places and that the cast-iron lining has become seriously flattened for some distance. Altogether, it is stated, some 1,600 ft. of the cast-iron tubing will have to be repaired. Mr. Geo. S. Rice, Chief Engineer, Rapid Transit Commission, has made the following statement:

The stretch which has been affected in the East River tunnel lies under the Brooklyn shore. Part of it is under the river and part under Joralemon St. In spots there have been sinkages, and this has caused a depression in the tops of the tubes, and it is true that in some places not a sufficiently large clearance has been left to prevent the trains scraping against the side of the tunnel. Several hundred feet of the depressions have been remedied. This has been done by taking out the bottom plates of the tube and fitting in others which allowed for lowering the floor of the tunnel.

SURVEYS FOR THE GEORGIAN BAY SHIP CANAL are reported on by Mr. A. St. Laurent, Engineer-in-chief. It is stated that the proposed navigation route from the mouth of the French River, on the Georgian Bay, to Montreal, covers a distance of 425 miles. The route, which is being surveyed, has been divided into three districts, designated as the Nipissing, Ottawa and Montreal Districts. On the western end the survey has proceeded on the assumption of a summit level at or about Trout Lake elevation. This was done because the raising of Lake Nipissing 18 to 20 ft., as proposed in the old surveys, is considered altogether impracticable in view of the settlement around the lake, involving, as it would, the flooding of a portion of the town of North Bay, and also the main line of the Canadian Pacific Railway. On the contrary, the cutting down of the whole summit level to Lake Nipissing level would entail a very large expenditure to give a first-class canal for large vessels. Three different routes are being surveyed in the Western division. It is mentioned that the water supply at the height of land has been studied for a possible traffic of from ten to twenty million tons. The investigation so far, though not complete, seems to indicate that the supply from the immediate watershed of Trout, Turtle and Talon Lakes at the height of land will not be sufficient for the amount of traffic assumed, but the possibility of getting an extra supply of water from an adjacent watershed and by impounding water, is now being looked into with every chance of meeting with favorable conditions. The engineers are now at work on the plans, profiles and estimates of cost.

A NEW HYDRO-ELECTRIC POWER STATION for supplying additional power to the Montreal Light, Heat & Power Co., of Montreal, Canada, is worthy of note. The initial installation will consist of three 3,750-KW., three-phase, revolving field, alternating current, water-wheel driven generators of 4,000 volts and 7,200 alternations; also twelve 2,500-KW., 44,000 volts, oil-insulated, water-cooled transformers. The step-up transformers will be wound for 4,000 to 44,000 volts, while the step-down transformers will be from 40,000 to 12,500 volts. The transmission line is about 40 miles in length.

PERSONALS

Mr. Kirby D. MacLean, Assistant Engineer in the Reclamation Service has resigned.

Mr. Randolph D. Talmage has been appointed Local Manager of the Sullivan Machinery Co., at Joplin, Mo., to succeed Mr. S. A. Allison.

Mr. George A. Lund has accepted the position of Contracting Manager, Post & McCord, of New York City, Steel Contractors.

Mr. M. C. Sturtevant has been appointed General Assistant of the Grand Trunk Pacific Ry., with office at Winnipeg, Man.

Mr. F. S. Badger has removed from San Francisco to Monterey, Mexico, to accept the position of Principal Assistant Engineer of the Compania de Servicio de Agua y Drenaje de Monterey, S. A.

Mr. Axel Ames, Jr., has been appointed Signal Engineer of the Electric Zone, of the New York Central & Hudson River R. R., to succeed Mr. W. H. Elliott, assigned to other duties.

Mr. Wm. L. O'Connell, who has been Deputy Commissioner of Public Works since the resignation of Mr. M. L. Patterson, has been appointed Commissioner of Public Works of Chicago, Ill.

Mr. Charles J. Steffens, for several years Assistant Engineer for the Guarantee Construction Co., 72 Trinity Place, New York City, has just been made Manager of that company.

Mr. E. C. Brown, for several years Engineer of Maintenance of Way of the Union Railroad, a subsidiary company of the United States Steel Corporation, has been promoted to the Chief Engineership of the Carnegie Steel Co.

Mr. H. C. Baker, formerly in charge of the Atlanta office territory of the Crocker-Wheeler Co., has been put in charge of the Pacific Coast territory. Temporary offices have been established at 2611 Broadway, San Francisco, as the offices at Fremont and Howard St. were completely destroyed by the recent fire.

Obituary.

Lewis William Washington, former Vice-President of the Pittsburg Sheet Steel Mfg. Co., of Pittsburg, Pa., died May 15 at Nice, France.

Edward R. Beardsley died at his home in Hartford, Conn., May 19 of jaundice, aged 67 years. Mr. Beardsley was a graduate of Yale University and for 30 years was secretary of the old Hartford & Connecticut Western Ry.

ENGINEERING SOCIETIES.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
May 28 to June 1. Annual convention at Milwaukee, Wis. Secy., Ralph W. Pope, New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 5. Annual meeting at Atlantic City, N. J. Secy., W. C. L. Eglin, 136 Liberty St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 5 to 7. Annual convention at Cleveland, Ohio. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
June 13. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, 658 Rookery, Chicago, Ill.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 18. Annual convention at Atlantic City, N. J. Secy., J. W. Taylor, Old Colony Bldg., Chicago, Ill.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 21-23. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 26. Annual convention at Thousand Islands, N. Y. Secy., Chas. Warren Hunt, 220 West 57th St., New York, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 29 to July 4. Annual meeting at Ithaca, N. Y. Secy., M. S. Ketchum, University of Colorado, Boulder, Colo.

AMERICAN WATER-WORKS ASSOCIATION.
July 10 to 14, inclusive. Annual meeting at Boston, Mass. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 19 to 20. Semi-annual meeting at Chicago, Ill. Secy., W. M. Mackay, P. O. Box 1818, New York City.

AMERICAN INSTITUTE OF MINING ENGINEERS.
July 23 to Aug. 4. Joint meeting with the Iron and Steel Institute at London. Secy., R. W. Raymond, New York City.

MICHIGAN STATE BOARD OF HEALTH.—The ninth general conference of the Health Officers in Michigan will be held May 31 and June 1 in the Auditorium of the Ladies' Literary Club Building, Grand Rapids, Mich. Thirteen papers will be read and discussed, the one of most interest to engineers being "Public Water Supply and Sewerage," Dr. R. W. Chivers.

WASHINGTON SOCIETY OF ENGINEERS.—The regular meeting of the society was held in Hubbard Memorial Hall, May 15. Mr. David E. McComb, Superintendent of Sewers of the District of Columbia, read a paper describing the general topographic conditions and the development of the sewer system of the District. Mr. A. E. Phillips followed with a paper, which described the methods of construction, and in particular gave details of the pumping station and the outfall sewer.

SOCIETY OF ENGINEERS OF EASTERN NEW YORK.—A regular meeting of the society was held May 18 at Albany, in the rooms of the Albany Institute and Historical and Art Society. Mr. F. H. Newell, Chief Engineer of the Reclamation Service of the Department of the Interior, gave a talk on the subject "Irrigation and Reclamation of the Arid Lands in the West."

At the business meeting the President was authorized to appoint a committee to take up the matter of [illegible] suitable engineering works and rooms provided [illegible] new State Library for the engineering profession.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The thirty-eighth annual convention will be held at the Frontenac," Thousand Islands, Frontenac, N. Y. June 26 to 29. This hotel will be the headquarters throughout the convention. The mornings will be devoted to business sessions and topical discussions, while the afternoons and evenings are left open for pleasure. The report of the Special Committee on a proposed Amendment to the Constitution will be presented to the convention for action and the following subjects discussed: "What is the Best Preparatory Education for the Civil Engineering Profession?" "Is Technical Training the Best Education for Executive Work?" "The Protection of the Intellectual Property of Civil Engineers;" "The Advance in Sewage Disposal;" "What Are the Best Means for the Prevention of Conflagrations in Large Cities?" "The Filtration of Water."

WESTERN RAILWAY CLUB.—At the meeting held at the Auditorium Hotel, Chicago, on May 16 Mr. S. W. Dudley, Assistant to the Mechanical Engineer of the Westinghouse Air Brake Co., presented a paper, entitled "What Stops a Moving Train." The early use of chain brakes was briefly noted, but these were soon displaced as the advantages of compressed air became known. The straight-air, slow-action, non-automatic air-brake was soon followed by the automatic air-brake. This was the last radical change in the principles of brake operation, and since then the improvements have been along the line of increasing the rapidity, power and flexibility of operation of the automatic brake. These have resulted in the quick-action, high-speed brakes, and the more recent quick-service, graduated-release and quick-recharging brake systems. The paper then proceeded to discuss the relation of weight and speed of train to the braking power, both theoretically and in regard to practical considerations. The discussion turned largely upon the use of the brakes in actual service, particularly in regard to the parting of heavy trains.

This being the annual meeting, the annual reports of the secretary and treasurer were presented, and showed a present membership of 1,271, and a bank balance of $1,452. Officers were elected as follows: President, H. T. Bentley (C. & N. W. Ry); Vice-Presidents, C. A. Seley and M. K. Barnum; Treasurer, P. H. Peck; Secretary, J. W. Taylor, 390 Old Colony Building, Chicago.

WESTERN SOCIETY OF ENGINEERS.—At the meeting held at the society's rooms in Chicago on May 16 the postponed discussion of Mr. Cartlidge's paper on "The Design of Swing Bridges from a Maintenance Standpoint" (Engineering News, April 26) was reopened by Mr. W. H. Finley (C. & N. W. Ry.), who referred, among other things, to the cost of operating bridges by steam and gas engines and electric motors. Mr. F. H. Bainbridge (C. & N. W. Ry.) did not approve of the toggle end-lift arrangement described in the paper, but preferred a rocker bearing raised and lowered by the eccentric motion of an offset shaft, as designed by the late C. Shaler Smith and used on the Chicago, Milwaukee & St. Paul Ry. The oil used for lubrication is a consideration, especially where severe cold occurs, as few oils retain their efficiency at 20 or 30° below zero. The Kinnickinnic River bridge at Milwaukee has a 20-in. phosphor-bronze disk on a 20-in. steel disk, with black oil for lubrication; the noise could be heard at a great distance and the bridge swung with a jerky motion. He was ordered to jack up the bridge so that it would bear entirely on the outer rim, but succeeded in getting a suitable oil used which remedied the trouble. Oil is also sometimes used on the treads of the wheels of the live ring if they are turning hard. Mr. Belknap considered the wedge preferable to the toggle for end lifts, and stated that of 11 swing bridges now being built by the Pennsylvania Steel Co., nine have center bearings, and the other two have a combined center and rim bearing.

The Secretary also read a short paper by Gen. Wm. Sooy Smith on "Fireproofed Steel Construction of Buildings," which suggested the use of wire lath or netting with plaster instead of brick, concrete or stone. The substance of the paper was that if the steel skeleton is covered with metal lathing, strong wire cloth or expanded metal lathing, heavily plastered inside and covered with stucco on the outside, roof and all, using an asbestic or other equally good fireproofing material, mixed with quick lime on the inside and Portland cement on the outside, it will be safely protected from corrosion and heat, and the stucco will be as hard and durable as stone. In case the plaster and stucco are shattered (which can hardly occur as they are strongly reinforced by the steel lathing) and knocked off by heavy strains or shocks, the steel frame will not be injured nor will life be destroyed by the fall of the small fragments.

At a meeting of the Electrical Section on May 18 Mr. H. R. King presented a paper on "The Hawthorne Shops of the Western Electric Co."